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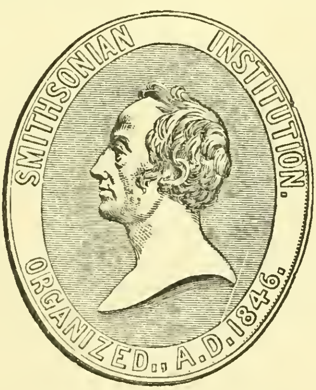

" EVERY MAN IS A VALUABLE MEMBER OF SOCIETY WHO BY HIS OBSERVATIONS, RESEARCHES, AND EXPERIMENTS PROCURES KNOWLEDGE FOR MEN."—SMITHSON.

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JOSEPH HENRY,
Secretary S. I.

Smithsonian Report.

ON

RECENT IMPROVEMENTS

IN THE

CHEMICAL ARTS.

BY

PROFESSOR JAMES C. BOOTH,

AND

CAMPBELL MORFIT.

WASHINGTON CITY:
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PREFACE.

The following Report has been prepared under the direction and at the expense of the Smithsonian Institution, from articles in various Journals of Science and the Arts, published during the last few years, in the English, French, and German languages; and, among these, we acknowledge our indebtedness chiefly to the Chemical Gazette, issued in London, and to the excellent Report on Practical Chemistry, by Dr. Elsner, of Berlin. We have freely exercised discrimination in the selection of subjects, and have omitted much that we found on Applied Chemistry, because novel views need in many cases further confirmation to render them reliable in practice, and, if presented too early to the artisan, may be productive of more evil than good. We have kept in view the benefit of the practical man, the manufacturer or maker, and, while we have not avoided scientific terms when more convenient, we have generally used modes of description intelligible to every one.

American Patents relating to the Chemical Arts have been generally omitted, because they are published annually in the Reports of the Patent Office, which are widely distributed throughout the United States, and therefore accessible to all.

We have confined ourselves to such foreign improvements in the Chemical Arts, whether patented or not, as we believed the American artisan might avail himself of, frequently offering critical remarks on them, and sometimes pointing out where improvements were likely to be made.

We trust that the work will prove useful to that portion of the public more exclusively interested in the arts, and not less acceptable to men of science, as exhibiting the contemporaneous advancement of science and art.

J. C. B. and C. M.

PHILADELPHIA, JULY, 1851.

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CHEMICAL TECHNOLOGY.

CLASSIFICATION OF THE CHEMICAL ARTS.

The arts are those processes by which the products of the mineral, vegetable, and animal kingdoms are modified, in a greater or less degree, in order to adapt them to the wants of man. These processes are based on either mechanical or chemical principles; and while in a large proportion of them mechanics are almost exclusively employed, in an equally large number mechanical operations are merely subservient to chemical action. Hence, a twofold division of the arts is both practicable and convenient. The former is designated as Mechanical Technology, or Practical Mechanics; the latter, Chemical Technology.

Among the chemical arts, many are conducted on a large scale, and are properly termed chemical manufactures; but chemical technology is more comprehensive, embracing less extended processes, and even a few in which chemistry finds a limited application. Thus, the making of alum and glass, the reduction of iron ores, the extraction and refining of sugar, are all manufactures conducted on a vast scale. On the other hand, phosphate of soda and chrome yellow are made on a limited scale; small quantities of nickel, of tannin, and perfuming oils, are extracted and refined; and yet, as their preparation is wholly governed by chemical principles, these processes belong to chemical technology. While some writers incorrectly limit the subject to chemical manufactures, others confine it to the first valuable products obtained. Thus, while the preparation of alum and copperas are acknowledged

chemical arts and manufactures, their extensive application to organic fibre to give permanency to dyes, and the whole art of dyeing and calico-printing, would be excluded. This is manifestly wrong, if the definition of the arts which we have given be correct; and we cannot exclude those arts of a chemical nature, which more immediately flow from any one branch of manufacture, especially when we consider that such collateral arts are often necessary to the economy of a particular branch of manufacture.

Emanating from chemistry, chemical technology has been usually treated as a branch of that science, and has been correctly designated "applied chemistry." Its recent expansion, however, by the aid of chemistry, allows of its establishment as an independent branch of knowledge,—a science, capable of a classification, not on the principles of chemical science, but evolved from itself, by a comparison of its subjects with each other. The main principle which should govern such classification is the object in view or the product to be made, and, with this, the secondary arts necessarily or usually connected with it. Thus, the making of soap, being an important art, and an extensive manufacture, necessarily includes the extraction and purification of oils and fats, while perfumery and chandlery seem to follow in its train in a natural order. The following is an attempt at such a classification of the subjects in chemical technology, and is the result of some years' experience in lectures on the chemical arts, delivered by the writer before the Franklin Institute of Philadelphia. Doubtless, it will be found imperfect, but it is fair to offer as an apology, the difficulty experienced by the chemist in separating in his mind the composition and properties of bodies from their connection as objects of manufacture, and in breaking down long-cherished associations of purely chemical characteristics.

Chemical affinity may be regarded as the force employed in the chemical arts; fuel and water, as the principal agents used to modify or direct this force; and the crude productions of the mineral, vegetable, and animal kingdoms, as the materials

subjected to action. The air performs less important functions, as a direct agent; but, in conjunction with fuel, it is indirectly an indispensable agent, in developing heat by the union of its oxygen with the carbon and hydrogen of fuel. Fuel is, however, the true agent in this case, practically considered, because it can be handled, weighed, and measured, by the artisan, and is indispensable in the reduction of metallic ores. We therefore regard fuel as the source of heat in the arts; and since the larger proportion of the more important technical processes are more or less controlled by heat, it must be viewed as the principal agent or modifier of affinity. Hence the sources and management of heat should be the first subject treated of in a classified narration of technical processes. It may be followed by its application to the warming of buildings, which, in its manifold aspects of economy, convenience, safety, and the health of man, embraces the forms of apparatus in which it is employed, and the subject of ventilation.

More naturally connected with fuel than with any other department of the arts are the means of obtaining and of extinguishing fire: the preparation of those mixtures of combustibles with condensed forms of oxygen, such as gunpowder, and other projectile and destructive agents, together with their allied compositions for ornamental displays of fire. These may be embraced under the term Pyrotechny.

The whole of the first subject, included under the term *Calorics,* admits of the three subdivisions or groups: Fuel and Furnaces, Warming and Ventilation, and Pyrotechny.

One of the simpler applications of heat to modify mineral substances, is the fusion of sand and alkali to glass, which is highly plastic when sufficiently heated, and in that state receives the form which it retains on cooling. Another application is to the semi-fusion or baking of clay-ware, which, having been previously plastic by admixture with water, and having then received its form, is heated to a point below perfect fusion to give that form permanence. Allied to these is another plastic art: the making and use of cements and mortars, including plaster-

casting, and making artificial stone. All these are embraced under the general term of *Plastics;* of which glass-making is Pyroplastics; cements, Hydroplastics; while the art of potting partakes of the character of each.

Another important but more complex application of fire is to *Metallurgy*, wherein fuel is both the source of heat and the chief means of reducing ores to the metallic state. It will be observed, that, while the fluxing of ores naturally connects metallurgy with the pyroplastic arts of glass and pottery, the construction of furnaces and moulds indicates its dependence upon hydroplastics. Modern chemistry has enriched metallurgy with a new department, Galvanoplastics, and with a variety of processes in which the metallurgic treatment of ores is effected by solutions. We may, therefore, conveniently divide the subject into Pyrometallurgy and Hydrometallurgy. For the present, it is proper to regard Photography as a branch of the latter, with which it stands in intimate connection.

Metallurgy and plastics, having each their branches, in which aqueous action plays a conspicuous part, are thus naturally linked with a long series of arts in which water is the prime agent in modifying and directing the force, affinity; and the connection is still further established by the fact, that the substances acted on are mostly confined to those of the preceding classes, alkali, earth, and metal. The arts in the present class, having for their chief object the preparation of simple chemical compounds, acid, oxide, and salt, and being conducted on purely chemical principles, have received the general term of *Chemics.* Water is the medium of action, the solvent for acid and alkali, in which they exert their powerful and contrary effects; the solvent for salts, in which they are decomposed and resolved into new and useful compounds. The manufacture of sulphuric acid, usually regarded as the keystone of the more purely chemical arts, and its use in transforming common salt into the alkali soda, introduces a series of various connected and derivative arts, conducted on a large scale, whose elements are to be found in plastics, and which may constitute a convenient division of chemics, called

Salines, or the saline arts. While we have seen the arts of the preceding class extract the metals from their ores, the next division of chemics subjects them to such treatment in solution, as to convert them into many useful compounds, such as pigments, salts employed in dying tissues, &c. This group contitutes the Metallosalines. The making of fine chemicals and pharmaceutic preparations is connected intimately with the preceding saline arts, being conducted in a similar manner, but on a smaller scale, and with greater nicety; it also depends chiefly on the products of those arts as its means of action, and partly on them for materials to be acted on. This forms, therefore, the third group of the chemic arts.

It may have been observed that the arts of the preceding classes are chiefly devoted to the preparation of tools whereby to work upon, vessels wherein to operate upon, or materials wherewith to modify the various crude productions of organic and partly inorganic nature, in order to adapt them to the manifold wants of man, whether to minister to his comfort or luxury. Clothing, food, and the comforts of life are therefore mainly embraced by the following technical processes. The most extended application of the chemical products derived from the preceding class, is to the ornamenting and modification of tissues, which embraces the beautiful and varied arts of dyeing and calico-printing, or ornamenting Textile fabrics. With these are linked the kindred arts of making Sheet-fabrics, paper, leather, &c., as well as working in caoutchouc and gutta percha. To modify and ornament fibrous, sheet, and solid tissues, varnishes and cements are employed, and are classed under the general term Adhesives. The principal subjects of this class being the ornamenting of woven fabrics, it has received the name *Calistics*, (καλος, and ἱστος, *loom.*)

The use of soap for general purposes of cleansing, and chiefly of cleansing textile fabrics, follows the preceding in a natural sequence, and serves to group a series of arts, rather allied by unity of material on which they operate than by unity of object in view. They include the extraction and purifica-

tion of oils and fats, the preparation of soap, and the various articles of the perfumer; and, lastly, Illumination, which includes chandlery, the manufacture of gas, with the various substances and apparatus which afford light, such as burning-fluids, lamps, and jets. *Oleics* is an appropriate term for the class.

After the arts which supply man with clothing and minister to other external wants, those which afford him nourishment follow, and may be conveniently grouped under the term *Sitepsics*, (σιτος, *food*, and ἑψω, *cook*, *prepare.*) The extraction of farinas and sugar, with the refining of the latter, are followed by their modification under the singular process of fermentation and conversion into alcohol, which, in its turn, is readily changed into vinegar during the acetous fermentation. The various culinary arts form another convenient group of the domestic arts, embracing the preparation and preservation of food.

The whole series of chemical arts may be closed by chemical agriculture, or the art of directing and controlling the growth of plants and animals, whence its name *Biotechnics*, (βιος, *life*, τεχνη, *art*,) in order to render their products, in quantity and quality, most suitable to the demands of the arts or the more immediate wants of man. To effect this, the influence of the air, water, and soil, of mineral substances and manures, on the growth and productions of plants, must be studied; the composition of their ashes, under different circumstances of growth and product, examined; the influence of food and other circumstances on the growth of animals and of their parts, such as hair, horn, fat, &c., must be investigated. These important observations in organic life constitute a true art, as yet in its infancy; and it is of a chemical character, so far as it is pursued with a chemical object in view, (the quantity and quality of organic product,) and by chemical agency, (minute, practical analysis.) We may consider it under the several heads,—of the chemical changes observed in the formation of useful products in plants and animals, including the peculiar chemical character of such products; of the in-

fluence of mineral and organic manures on the special products of plants, and of various conditions on the products of animals; and the examination of the ashes of organized bodies, with a view of supplying such as may be required for obtaining special products. These subjects are most conveniently grouped in this manner at the present time; but as the art becomes more fully developed, the very different nature of plants and animals, and the different influences exerted upon each domain of organic life, will cause their separation.

The following is a tabular view of the arts, classified in accordance with the principles above laid down.

JAMES C. BOOTH.

PHILADELPHIA, 17*th March*, 1851.

Tabular View of the Chemical Arts.

CLASS.	GROUP.	PRINCIPAL SUBJECTS.
I. Calorics.	1. Fuel and Furnaces.	Coal, wood, coke, &c. Reverberatory, blast furnaces, &c.
	2. Warming and Ventilation.	Stoves, hot air, steam, water.
	3. Pyrotechny.	Matches, gunpowder, fireworks.
II. Plastics.	1. Pyroplastics.	Glass, enamel.
	2. Pottery.	Brick, earthenware, porcelain.
	3. Hydroplastics.	Lime, mortar, gypsum.
III. Metallurgy.	1. Pyrometallurgy.	Reductions of ores by fire.
	2. Hydrometallurgy.	Galvanoplastics, photography.
IV. Chemics.	1. Salines.	Oil of vitriol, soda, nitre, alum.
	2. Metallosalines.	Metallic salts, pigments.
	3. Pharmaceutics.	Inorganic, organic.
V. Calistics.	1. Textile fabrics.	Bleaching, dyeing, calico-printing.
	2. Sheet fabrics.	Paper, leather, caoutchouc, gutta percha.
	3. Adhesives.	Resin, varnish, glue.
VI. Oleics.	1. Oils and Fats.	Extraction and fining, &c.
	2. Saponification.	Soap, essences, perfumery.
	3. Illumination.	Chandlery, gas, burning fluids, lamps, jets.
VII. Sitepsics.	1. Farina, &c.	Starch, flour, sugar.
	2. Fermentation.	Alcohol, wine, beer, vinegar.
	3. Culinary arts.	Preparation and preservation of food.
VIII. Biotechnics.	1. Physiology.	Plants and animals, ashes.
	2. Manures.	Putrefaction, mineral manures.
	3. Products.	Milk, fat, bone, horn.

I. CALORICS.

This general division of the chemical arts receives consideration from its principal subject, fuel, being the more important of the two chief agents employed in these arts to modify affinity, to break up existing, or to form new combinations. We cannot conveniently divide the arts according as they are acted upon by fuel or water, for these two prime agents are often employed simultaneously in a single process. While, therefore, the first classes of the arts are chiefly controlled by the action of heat, they are not exclusively so; and, again, those which follow, although depending mainly on solution, are likewise more or less influenced by temperature.

1. Fuel and Furnaces.

The various kinds of fuel employed in the arts may be most conveniently divided into two groups: those consisting chiefly of carbon, which burn without flame, and those containing both carbon and hydrogen, which burn with flame. The division is convenient, since flaming fuel is better adapted to certain arts, and flameless fuel to others; and in any particular art requiring one of these species, it is rarely a matter of moment which one of them is employed, the selection being usually one of economy or convenience. The following are the varieties of fuel:

Flameless.	*Flaming.*
Anthracite,	Bituminous coal,
Coke,	Wood,
Charcoal.	Rosin and Gas.

To each of these may be added artificial fuels, which may be made to burn either with or without flame.

The furnaces employed in the arts are the boiler furnace, or that employed to generate steam in a boiler, in which, flaming fuel being generally used, the fire is maintained by a

simple draft of air; the kiln, as the lime and brick kilns, to which flaming fuel is best adapted, and where the body to be heated may or may not be brought in contact with the fuel; the crucible furnace, in which a crucible containing the body to be melted or acted on is either surrounded by and in contact with flameless fuel, or in the glass and pottery furnaces, being at a distance from the fire, is heated by flame alone; the reverberatory furnace, in which the substance to be acted on is placed on a hearth and the flame from the fire place is deflected upon it by the low arched cover of the furnace; the blast furnace, in which the fuel, metallic ore, and flux being mingled in an upright shaft, an intense heat is obtained by forcing in a large amount of air by bellows driven by machinery. Although these are in general the different kinds of furnaces employed, yet their forms are constantly subject to variation, according to the special object in view and according to the theoretical notions of the manufacturer. Thus, when anthracite is used to generate steam, it is usual to drive a larger amount of air upon it by a fan-blast than could be supplied by a simple draft. Since the employment of anthracite in the iron blast-furnace, it has been found more advantageous to give greater width to the boshes.

Pungernite.—This new combustible, found by Bulganne in the Silurian formation of Russia, burns freely, but yields less carburetted hydrogen and heat than coal. Petzold's analysis (Athenæum, 1850) gives:

Organic matter	65.5
Silica	13.6
Ox. iron and alumina	2.3
Carbonate of lime	17.0
Carbonate of magnesia	0.2
Water	1.2
	99.8

Coal.—For a full view of the statistics of coal, we refer to the excellent work of Mr. Richard C. Taylor, who points out the various deposits of this mineral on the surface of the globe,

and, as far as practicable, their extent and value. For the evaporative power of coal, consult the papers of Dr. Fyfe, in the Philosophical Magazine, and the extended observations on American coals by Prof. W. R. Johnson, printed by order of Congress.

For full analyses of a large number (47) of coals, anthracite, bituminous, and brown coals, as well of turfs and a few woods, we refer to the An. Rep. of Liebig, Kopp, &c., p. 350, 1847–8. The same work, p. 353, gives the results of practical experiments, together with analyses of many English coals (30), conducted under the direction of De la Beche and Playfair. They determined, 1. The practical evaporative power, the number of pounds of water at 212° converted into steam by 1℔ fuel. The average was 8.695℔ water evaporated, the range being from 7 to 10. 2. The practical value after deducting the coal left in the ash. 3. The evaporative power calculated from the reduction of litharge by Berthier's process. 4. Weight of the fuel per cubic foot of stowage, from direct measurement. 5. Ditto, calculated from specific gravity. 6. Percentage loss by attrition. 7. Evaporative power, calculated from 2 and 4. We refer for these details to the paper in the Mechan. Mag. 1849.

Vaux's analyses of Engl. Coals, see in Journ. Fr. Inst. (3) xvii. 197.

Whoever witnesses the enormous amount of fine coal thrown in heaps near the anthracite mines, regarded as valueless and allowed to be washed away by streams, must have regretted the waste of a quantity of fuel which will never be recovered. Many patents have been issued in England with the view of saving fine culm, by mixing it with adhesive combustibles, such as coal, tar, &c., and pressing it into blocks. A late patent proposes mixing dried and ground spent tan with rosin-oil, or melted rosin, and compressing into blocks. (Lond. Journ. Sept. 1850.) Another patent (L. J. Oct. 1850) uses, also, refuse tan and peat with coal-tar, &c. But all these processes would seem to be ineffectual at our anthracite mines, because not sufficiently economical in comparison with the

price of coal. It is to be hoped that a process will yet be devised, by which the fine dust and waste may be rendered equal in value to the pure anthracite, or even superior to it for some purposes where more flame is required.

The use of plaster and other like cements, to unite fine coal into block or masses for fuel, as proposed by Hollands and Whittaker, (Lond. Journ. p. 39, 1849,) is objectionable, since it does not "add fuel to the fire," but 10 per cent. ashes, in addition to the larger amount of ash usually in fine culm.

Reverberatory Furnace.—The air is often admitted to the sides, &c. of a reverberatory, by leaving interstices for it to enter. Portions of melted matter dropping down, often choke these interstices; to prevent which, A. Dalton proposes making the upper part project over the openings. (Lond. Journ. xxxvii. Aug.)

Portable Blast Furnace.—Barron Brothers' blast furnaces require special notice, on account of the economy of time and fuel which their use exhibits, although the peculiar method of using the blast claimed for them has hitherto been applied only to small portable furnaces, used by jewellers, brass-founders, &c. This peculiarity consists in having the twyers of much larger dimensions than usual, and fitted with a straight pipe projecting some inches from the outside of the furnace, the size and projection proportioned to the size of the furnace. The blast, of moderate tension, issues from a nozzle a little less than the diameter of the pipe, into which it does not enter, but terminates just outside of it. The blast being urged, enters the pipe, and drawing in with it a body of surrounding air, with which it becomes mingled by the length of the pipe, enters the furnace as a broad current of air. The peculiar effect of the arrangement is shown by taking out the pipe, passing the nozzle into the twyer as in ordinary furnaces, and closing the twyer around it with clay. When thus circumstanced, there will not be melted more than from one-half to one-fourth of metal in a crucible put in the furnace, as will be melted when arranged as above described. The small portable blast furnaces are of four different sizes, adapted to

smaller or larger operations, whereby, as well as on account of the form of the furnace and the mode of blast, great economy of fuel is attained. They are accompanied by a table with cast-iron top, beneath which is a bellows worked by the foot, and through which three jets rise which can be adapted to the twyers of any of the furnaces. We give this detailed description, because our practical acquaintance with them in the operations of the laboratory enables us to give a most favourable opinion of their excellence; and, having seen them in operation in the hands of practical melters, for fusing, soldering, &c., we can speak of their general practical value in the arts. The enterprising originators of these furnaces are about applying the same principles to larger cupola furnaces for melting iron, and to other furnaces, large and small, for various metallurgic operations. They are made by Barron Brothers, No. 6 Platt street, New York.

2. Warming and Ventilation.

Little has been added to our stock of knowledge on these subjects during the last few years; but, if we were to apply what we already know, doubtless general health would be greatly benefited. Our public places of assemblage and our dwellings are heated to a tropical temperature, by air, the dust of which has been subjected to dry distillation by passing over a red-hot iron surface, and produced fumes of empyreumatic oils and tarry matters, which we endeavour most sedulously to prevent escaping, by barring up all avenues and chinks communicating with the external air, except those accidentally produced. In ventilation, there is still less attempted. It may be that masons and carpenters design to leave behind them, when their work is completed, a generally diffused system of ventilation, by half-filling the places in walls with mortar, and putting in green wood, which shrinks and cracks in every direction; but it is hardly necessary to say that this fanciful kind of ventilation is not based on very sound principles. It is sad to reflect on the badly heated and not ventilated school-rooms in the now widely diffused public-

school system, where some hundred thousand children in the United States, breathing a pestilential air, are shrivelled by a parching heat, and doubtless lay the foundation of life-shortening diseases. The remedy should be applied by the architects; but, since few of them have properly attended to this subject, those who engage their services should oblige them to defend us from internal inclemency of the weather by suitable arrangements for heating and ventilation, as well as from external inclemency, in the buildings they construct. Beside the essays of Reid on warming and ventilation, there is a small work in Weale's Rudimentary Series, published in 1850, which may be consulted. On the warming and ventilation of the Lunatic Asylum, Philadelphia, see Journ. Fr. Inst. (3) xix. 270.

3. Pyrotechny.

The discovery of the properties of gun-cotton has led to an attempt to find other compositions to replace gunpowder, one of which we notice.

A new Gunpowder.—Augendre has found that a mixture of 1 part yellow prussiate of potash, 1 part white sugar, and 2 parts chlorate of potassa, when separately reduced to a fine powder, and then mixed by hand in a wooden mortar, or larger quantities, moistened with 2 or 3 per cent. water, and mixed in a bronze mortar with a wooden pestle, and then granulated and dried in the usual way, will give a gunpowder which is readily fired by contact with an incandescent or lighted body. The mixed powders will act well without granulation. Its advantages are, that it is formed of substances of uniform composition, which are unalterable by dry or moist air; the powders may be kept separate, and mixed when wanted, and the mere mixture acting like the granulated powder; the force is greater than that of common gunpowder. Its disadvantages are that it inflames more readily than gunpowder; and it oxidizes iron barrels so much that its use must be confined to bronze metal.

Gun-cotton.—According to Marx (Pogg. An. lxxviii.) the average temperature at which gun-cotton explodes is 199°, if

suddenly raised, although it may explode at as low as 144°. By gradual elevation of the temperature, so as not to exceed five degrees per minute, the liability of explosion is considerably lessened. Care should be taken to pack it in vessels which will not convey heat interiorly, since metallic vessels may become heated to 144° by exposure to the sun's rays.

Averos (Comptes Rendus, xxiii.) gives the following as the results of his experiments on gun-cotton:

1. Equal parts of sulphuric and nitric acids, and clean cotton.
2. Time of exposure, 10–15 minutes.
3. The mixture may be used again.
4. The cotton should not project above the liquid.
5. It should be slowly dried, and not exposed to a heat above 212°.
6. The cotton acquires more force by impregnation with saltpeter.

Explosive paper is prepared, according to Pelouze, by dipping it for 20 minutes in concentrated nitric acid, washing it thoroughly with water, and drying it at a gentle heat. It takes fire at 356°, and explodes with great violence, leaving no residue.

Cotton has the formula $C_{24}H_{21}O_{21}$, and gun-cotton $C_{24}H_{16}N_5O_{41}=C_{24}H_{16}O_{16}+5NO_5$. Hence, 5 eq. water (HO) are removed from cotton and replaced by 5 eq. nitric acid; or H_5 are removed and replaced by $5NO_4$, thus, $C_{24}\begin{matrix}H_{16}\\(NO_4)_5\end{matrix}O_{21}$.

1 grm. gun-cotton yields by explosion 588 cub. cent. gas (at 32° and 0.76^m pressure), which has the following composition by volume:

17.03	carbonic acid.
47.45	carbonic oxide.
20.41	nitric oxide.
6.75	nitrogen.
8.36	carburetted hydrogen (CH).
100.00	

Charcoal.—Violette has applied highly heated steam to char wood, for the purpose of making a superior charcoal adapted to the manufacture of common gunpowder. The wood being enclosed in a cylinder, concentric within another which is heated, the steam from a low-pressure boiler is highly heated in a tube-coil, in the same fire which heats the cylinder, and enters the outer cylinder at one end, from which it enters the wood and expels the more aqueous and less combustible volatile portions. A black or red coal is produced, according to the heat and length of exposure to the steam. (Lond. Journ. 50. 1849, and J. Fr. Inst. (3) xvii. 281.)

Pure Oxygen.—According to Poggendorff, Chevreul, and Vogel, the oxygen made from commercial chlorate of potassa always contains chlorine derived from some perchlorate in the original salt. After repeated crystallizations the chlorate will yield pure oxygen. (Buch. Rep. iii.)

Preventing and extinguishing Combustion.—To render combustible substances incapable of combustion, at least incapable of spreading fire, is evidently a desideratum, and various substances have been proposed at different times to effect this result. In most cases they have been solutions, which are applied to the surface of wood, &c., and penetrate it but a short depth, or not at all. Of these, silicate of potassa (soluble glass) has been most preferred. Their action is, however, limited to the prevention of inflammation from sparks falling on a surface thus prepared. R. A. Smith (Phil. Mag. xxxiv. and Amer. Journ. 2d ser. viii. 118) proposes impregnating wood, &c. with a solution of sulphate of ammonia, which, if heated, is resolved into sulphurous acid, nitrogen, &c., which would tend to extinguish commencing combustion.

The following composition, among others, has been given for extinguishing fires: a mixture of 1 part powdered sulphur, 1 part red ochre, and 6 parts copperas, added to the water of a fire engine is said, from experiment, to do five times as much execution in extinguishing fire as water alone; it also diminishes the annoyance of smoke and steam. It doubtless operates in a large measure from the evolution of sulphurous

acid, but it is probable that anhydrous sulphuric would also be evolved.

Fire Extinguisher.—Phillips has invented an apparatus (Rep. Pat. Inv. Sept. 1850; Chemist, 1850, and Pharm. Jour. x.) for extinguishing fires by gases incompatible with combustion. It consists of an iron cylinder, 2 feet by 8 inches, having at its bottom a shallow chamber filled with water. There is also a smaller cylinder, connecting at the side, and enclosing a brick composed of nitre, charcoal powder, and sawdust. In the brick is a vial with two compartments,—the upper containing oil of vitriol, and the lower a mixture of chlorate of potassa and sugar. A plug is fitted into the cover of the apparatus in such a position that a sudden blow may cause it to crush the vial and thus ignite the contents. An instantaneous and forcible issue of carbonic acid and oxide, steam and nitrogen follows, and this stream of vapor, directed upon the blazing fire, smothers and extinguishes it.

Experiments have proved that this arrangement is not effective in open places, where the current of air is very strong. It may, however, be serviceable in confined places, such as the hold of a vessel.

II. PLASTICS.

1. Vitrification, or Glass-making.

We offer a few points in relation to glass, plain and colored, and introduce, also, the subject of gems, as most allied to glass.

Bohemian Glass.—The glass of which combustion tubes are made has been examined by Ronney, and found to consist of:

Silicic acid	73.13
Lime	10.43
Alumina	0.30
Sesquioxide of iron	0.13
Magnesia	0.26
Protoxide of manganese	0.46
Soda	3.07
Potassa	11.49
	99.27

Optical Glass.—Maes and Clémandot (Comtes Rendus, 1849), having studied the influence of borax in the manufacture of glass, have announced that the borosilicates of potassa, with lime, soda, or zinc, are eminently suited for optical purposes, owing to their remarkable hardness and transparency.

Colored Glass.—See an excellent essay by Bontemps, on the substances used for colored glass, in the Phil. Mag. (3 ser.) xxxv. 439.

Aventurine Glass.—Wöhler and others analyzed this glass, which comes from Venice; but Fremy and Clémandot have lately imitated it. (Comptes Rendus, Février, 1846.) They heated a mixture of 300 pts. powdered crystal glass (glass with a less portion of lead than flint-glass), 40 pts. suboxide

of copper, and 80 pts. iron scales (smithy slack), for 12 hours, and suffered the fused mass to cool slowly. The oxide of copper is reduced by the iron, which latter forms a silicate that scarcely tinges the glass, while the minute crystals of metallic copper, suspended in the glass, impart to it its peculiar appearance.

Hæmatinone is the name of a beautiful, red, opake glass, employed by the ancients in mosaics. Analysis showing its coloring matter to be copper, Pettenkofer asserts that he has succeeded in producing it, and that it can be made in quantity. A similar glass is not unfrequently obtained in testing copper with borax by the blowpipe.

Ruby-glass.—H. Rose has examined gold-glass and gives the following views on it. (Verhandl. d. Berl. Acad. and Journ. f. Pract. Chem. xliii. 75.) When colorless gold-glass is gently ignited, it become ruby-red, still retaining its transparency, whether heated in oxygen or carbonic acid. The red glass fuses in the flame of the hydroxygen blowpipe to colorless drops, which do not redden again by heat. Splittberger thinks that the colorless glass contains peroxide of gold, and that this is reduced to protoxide, which precipitates and colors the glass red. Rose holds that the peroxide is not contained in the glass, because it is a very feeble base, if a base at all, and because the reddening may occur in oxygen. But as the protoxide is a base, forming salts, some of which are quite fixed at a high temperature, (as the purple of Cassius, which Berzelius regarded as stannate of protoxide of tin and protoxide of gold,) Rose assumes a protosilicate of gold in the colorless glass, from which heat precipitates the protoxide and gives the red color. He compares it to glass colored red by suboxide of copper, which is colorless after fusion and becomes red by reheating, and that this change takes place even when the colorless copper-glass is covered on both sides by common flint-glass. He further supports his view by the similar atomic composition of suboxides of copper and gold. The brownish color of gold-glass, too highly heated, he refers to a reduction of oxide of gold to the metallic state.

It should be mentioned that some chemists hold that the red color is due to the precipitation of metallic gold.

Hydrated Silicic Acid.—Ebelmen's neutral silicic ether (silicate of oxide of ethyl) is slowly decomposed by the moisture of the air, yielding alcohol, and hydrated silicic acid ($2SiO_3$, $3HO$), which resembles natural silica, scratches glass, and has a spec. grav. of 1.77. By mixing colored tinctures with the ether, the silica may be obtained of various colors.

Artificial Brilliants.—Those from Austrich in Paris, analysed by Köttig (Journ. f. Pract. Chem. xxxiv. 458), consist of 38.8 silica, 53 oxide of lead, and 8.2 potassa and soda, with traces of iron and alumina. They are therefore similar to paste (or strass), and exhibit much brilliancy and refraction.

Artificial Gems.—To make gems, Ebelmen avails himself of the two properties of boracic acid, of dissolving metallic oxides by fusion, and volatilizing at a higher heat. His process resembles the solution of substances in water and the evaporation of that water to obtain crystals. Having made a mixture of alumina and magnesia, in the same proportion as they exist in spinell, and added $\frac{1}{2}$–1 per cent. bichromate of potash, he added to 2 pts. of this mixture 1 pt. fused boracic acid, and exposed it in platinum resting in porcelain to the heat of the porcelain furnace of Sèvres. The product contained cavities lined with minute, rose-red, octahedral crystals, harder than quartz and infusible before the blowpipe. They had all the characters of ruby. The constituents of emerald, treated in the same way, yielded small hexagonal crystals, harder than quartz, and therefore agreeing with true emerald.

Grinding and Cutting.—For a full account of the emery localities of Asia Minor, see J. L. Smith, in Amer. Journ. 2d ser. x. 354, &c., and in Lond. Journ. Oct. 1850.

Diamond Carbon.—For an account of this curious substance, see Journ. Fr. Inst. (3) xvii. 47.

Coke.—According to J. Nasmyth (Ch. Gaz. vi.), common coke possesses the property of cutting glass in as clean and perfect a manner as the diamond.

Silvering.—Glass vessels may be beautifully ornamented by

coating one surface (the inner, if hollow) with a silvering liquid (see Hydrometallurgy), and then cutting or otherwise ornamenting the outer surface. (Thomson and Varnish, in Lond. Journ. xxxvii. Aug.)

2. Semivitrification,

Or the making of brick, earthen-ware, stone-ware, fine pottery, and porcelain. The basis of these arts is clay, which is often unmixed for brick; consists of finer and coarser clays for earthen-ware; of still better for stone-ware; of the best clays, quartz, and feldspar, for fine pottery and porcelain. The materials for all these wares, except brick, are ground fine, made into a slip with water, partially dried to a plastic state, in which state they are formed, by pressing, throwing and moulding, into the endless varieties of forms which we daily witness. A glaze is given to the surface by covering it with red lead, for common ware; with a fusible flux or glass containing lead, for the better wares; and with a glaze chiefly composed of feldspar, for porcelain. A very high heat is given to common earthen-ware, and a much higher to porcelain, sufficient to cause the ware to undergo incipient fusion. The subject presents a wide field for improvement by the application of chemical principles, although at the present time we need more of sound practice in the United States, especially in the finer kinds of clay-ware. Our common and fire bricks, and common earthen-ware and stone-ware, are already of excellent quality, and our black-lead crucibles are superior to the German, the best being made at Taunton, Mass., and Jersey City, opposite New York. We employ pots from both establishments at the United States Mint, and melt in them about 2500 oz. gold at once. Although the quality is not uniform, they are generally excellent.

Some attempts have been made to produce fine pottery (Faience, Liverpool-ware), but few have met with success: and among the latter we may mention the Pottery Company at Jersey City, and the Spring Garden Pottery, Philadelphia.

Porcelain was made at Jersey City in 1816, and a successful establishment was conducted at Philadelphia for some years, but closed in 1836. Stone-ware of good quality is made in many places, especially in New York, Philadelphia, and Baltimore, but it is not yet equal in quality to the Lambeth-ware of London. We believe the location is yet to be found, where many potteries can gain a permanent foothold; the first essential being bituminous coal; the next, good clays in some abundance; and the third, facility of communication by water or railroad. The finer qualites of clay and feldspar will bear transportation, and may even be obtained on our seaboard, from Devonshire, &c., England, at about the same cost as they are in the Staffordshire potteries. The most likely position for a potting district is in western Pennsylvania, or on a few points on the Ohio or Missouri rivers, where the first and greatest essential, fuel, is abundant.

There are few novel points of interest in these arts, which we present below. The general principles of painting and staining glass and clay-ware are so similar that they may be treated together, although we have separated them for convenience.

Fire-clay from fusible clay.—Gaffard gives the following method of effecting this result. (L'Institut, No. 594, p. 175; Berz. Jahresb. 1846, 293.) A good quality of clay, but not fire-clay, is mixed to a paste with muriatic acid, and, after some time, heated to boiling. The acid is run off, and the clay fully washed and dried. Clay, thus treated, was made into crucibles, in which bar-iron was fused, without their becoming softened by the heat. The acid simply extracts a large proportion of those bases (lime, iron, &c.) which tend to flux the principal part of clay, the silica and alumina; but the question of economy will influence the use of this remedy for the fusibility of clay, and it is doubtful whether the process will be adopted by manufacturers.

Porcelain.—An interesting series of experiments has been made by Dr. Wächter in Berlin, in which he ignited various mixtures of feldspar and kaolin, and, in connection with Dr.

Oschatz, examined the products microscopically. The result was a refutation of the usually received opinion that porcelain is a mere mixture of fused feldspar and unaltered kaolin, the latter of which is the cause of its opacity; for it was shown that it consists of a glassy mass, filled with an infinite number of minute needle-shaped crystals, which produce the opacity of porcelain.

Wilson's analysis of Berlin porcelain gave the following results:

Silica	71.34
Alumina	23.76
Oxide of iron	1.74
Lime	0.57
Magnesia	0.19
Potassa	2.00
	99.60

Couper has published a series of analyses of the materials and products of English potteries, in Phil. Mag. (3) xxxi. 435, to which we refer for details.

Yellow Flux for Porcelain Colors.—Salvetat's analysis of such a flux from Sèvres, led him to make a similar one of the following composition: 88 pts. gray flux, 3½ pts. oxide of zinc, 7 pts. hydrated peroxide of iron, and 1½ pts. binantimoniate of potassa. The zinc is prepared in the dry way, and the gray flux consists of 22 pts. sand, 11 pts. fused borax, and 66 pts. red-lead. The substances are finely powdered, fused twice and cast out on an iron plate. It facilitates the fusion of colors and gives them body without altering their tone, as it is itself very pale.

Aventurine Glaze for Porcelain.—Wæchter (Liebig's Annalen, 1849; Amer. Journ. 2d ser. viii. 440, and Chem. Gaz. 1849) proposes the following enamel for porcelain, in which the golden iridescence is produced by a crystalline separation of oxide of chromium from the brown ferruginous mass of the glaze:

Porcelain clay from Halle, washed over and dried	31
Dry quartz sand	43
Gypsum	14
Porcelain cullet	12

It is to be mixed thoroughly with 300 pts. of water, and then incorporated successively with aqueous solutions of

Bichromate of potassa	19
Protosulphate of iron	100
Acetate of lead	47

Ammonia is now added until the complete separation of the iron, and the potassa and ammonia salts then removed by washing and decantation.

Red Pigments for Porcelain.—Salvetat, in his elaborate and valuable paper (Ann. de Chem. et de Phys. 1849) upon the red pigments used in porcelain painting, gives analyses of the celebrated chromatic series known as Pannetier's. The shades which they impart are said to be unequalled for beauty, brilliancy, and transparency.

The series consists of eleven tints, as follows:

Orange.
No. 1, or Capucin red.
No. 2, or blood "
No. 3, or flesh "
No. 4, or carmine "
No. 5, or lake "
No. 6, or pale violet red.
No. 7, or iron " "
No. 8, or dark " "
No. 9, or very dark violet red.
Gray.

The flux is the same for all, and consists of silex, borax, and minium. The coloring matter of all but the orange and Nos. 8, 9, 10, is exclusively peroxide of iron; and the modifications of tint are due to a variation of the proportions, and particularly to a difference in the intensity of heat employed.

The orange contains, in addition to oxide of iron and flux, some oxide of zinc, with traces of alumina; and Nos. 8, 9, and 10 have oxide of manganese as part of their composition. The traces of alumina found in some of them do not act any important part, as its presence is not necessary in the preparation of vitrifiable pigments.

These tints are not equally permanent. The strength and blueness of tone increases with the temperature to which the pigment is subjected; the yellow tint predominating at low heats. The greatest purity is insured by using coloring matter prepared so carefully that every particle has been heated, uniformly, to the same temperature.

Gray Enamel for Porcelain.—Salvetat (Ann. de Chim. et de Phys. xxv. 342) has given a recipe for a new gray color for porcelain. It is more durable, and more certain and constant in its results, than the usual grays; and, on account of its agreeable tone, greater economy, and facility of preparation, has been introduced into the works at Sèvres, as a substitute for iridium gray. It is prepared by mixing together 1 pt. of platinum powder with 3 pts. of glass, formed of 1 pt. sand, 3 pts. minium, and a half part calcined borax.

Cement for Pottery and Glass.—Wächter describes a fusible cement for glass or pottery, which consists of 3 pts. red-lead, 2 pts. white sand, and 3 pts. crystallized boracic acid. They are well mixed in powder, fused in a Hessian crucible, poured out on a metallic plate, and ground fine. When used, it is mixed with tragacanth paste and applied to the parts to be joined, and the piece is then heated in a muffle at a low heat, not quite sufficient to melt the enamel.

3. Hydroplastics,

Or making and using mortars, plaster casts, and artificial stone. Under this head may also be included lime and limekilns, hydraulic cements, asphalt pavements, and mastic used for coating walls. There is not much of novelty to offer in relation to this subject.

C. Morfit gives the composition of a fresh oyster-shell, as follows:

Water	2.25
Organic matter	0.90
Carbonate of lime	93.89
Matters soluble in water:	
Alumina, magnesia, and phosphoric acid with lime	0.70
Chloride of sodium, with traces of sulphates of soda and lime	2.20
	99.94

Hydraulic Cement.—According to O. Ostermeier (Jahrb. f. Prac. Chem. xiv. 259), when finely powdered marble, limestone, or chalk, is mixed to a paste with milk of lime, it hardens rapidly, like hydraulic lime, has a feeble alkaline reaction, and resists water tolerably well. The mass is plastic and may be used to take large or small impressions. It forms a basic carbonate of lime, or, rather, a hydrocarbonate, which takes up water of crystallization. The analysis of a genuine Roman mortar from Pompeii leads to the inference that the Romans prepared their mortar from a mixture of caustic and carbonate of lime, with the addition of pulverized calcareous spar.

Kuhlmann's essay, in the Ann. de Chim. et de Phys. Nov. 1847, treats of the part performed by potassa and soda in hydraulic cement. He observes that most limestones, of whatever geological age, contain these alkalies, whence the fertility of a lime soil, and from which we can explain the alkaline efflorescence on newly-constructed walls. He states that a hydraulic cement is made when powdered chalk is moistened with a solution of silicate of potassa (soluble glass); that when exposed to the air, it gradually becomes harder than hydraulic cement; that there is formed some silicate of lime and carbonate of potassa. When chalk, mixed with water to a dough, is brought in contact with a solution of soluble glass (of soda or potassa), it becomes so hard in a few days as to scratch some marbles, exhibits a close grain, and admits of a fine

polish. Only 3–4 per cent. of silica, absorbed by the chalk, impart these properties. This material is well adapted to sculpture and various ornaments. Plaster of Paris (sulphate of lime), treated with soluble glass, is similarly silicated, and even plaster casts become hard and smooth on the surface. But the solution must be very dilute, or otherwise the surface cracks and scales off. If the articles to be hardened are to be exposed to the weather, the glass must be made with potassa, and not with soda, as the latter is more apt to effloresce. (See also Journ. Fr. Inst. (3) xvii. 201.)

The carbonic acid of the air acts an important part in the induration of these compounds, by abstracting the alkali of the silicate, and thus freeing the silica, which, by contracting, promotes the solidification.

Some of the most important principles in Kuhlmann's essay were published by Fuchs, in his excellent essays on lime and mortar (Erdmann's Journ. of Techn. Chem. vi.); on the properties and constituents of hydraulic cements (Polytech. Journ. xlix. 271); on soluble glass (Polytech. Journ. xvii. 465), &c.

A good essay on the action of carbonic acid in hydraulic cements, by Villeneuve, will be found in the Lond. Journ. Sept. 1850.

Prechtel gives the following simple mode of making hydraulic cement. Common burned lime is slacked with a solution of copperas, instead of with water, and then mixed with sand. (It may also be used without sand.) It hardens readily in the air or under water, and becomes very hard. Experiments made with it on a large scale proved very satisfactory. When freshly prepared, it has a greenish color, from the segregation of protoxide of iron, passing into peroxide, when its color is yellowish; and to this oxidation Prechtel ascribes its hardening property. Sulphate of lime is also formed at the same time, and probably a double carbonate. (Polytech. Notizbl. 1846.)

A slag, from an iron furnace, which forms, with lime, a hydraulic cement, has been found to consist of:

	Jacobi.	Grashof.
Silica	40.12	40.44
Alumina	15.37	15.38
Lime	36.02	33.10
Protoxide of manganese.	5.80	4.40
" iron	1.25	1.63
Potassa	2.25	2.07
Sulphur	0.70	0.76
	101.51	97.78

From these results, Elsner has deduced the formula $2(3CaO, SiO_3+Al_2O_3, SiO_3)+3CaO, 2SiO_3$.

See essays by Elsner on Puzzolan, &c., in Journ. f. Pract. Chem. 1844–1845, and on slags of blast-furnaces as hydraulic cements, in Verhandl. d. Gewerbv. f. Preussen, 1847. Those slags, decomposable by muriatic acid, are chiefly applicable to cements. The best method of testing them is to pulverize a piece very finely, and pour over it strong muriatic acid. If it become gelatinous in a short time, it is adapted to the purpose. A slag which was proved to be good for making the cement, had the composition: Silica, 40.12; alumina, 15.37; lime, 36.02; protoxide of manganese, 5.80; protoxide of iron, 1.25; potassa, 2.25; sulphur, 0.70 = 101.51.

Plaster, or gypsum, may be boiled or deprived of its moisture by highly-heated steam, as described by Violette. (See Lond. Journ. p. 424, 1849.) See the apparatus for charring described in the present Report, under Pyrotechny, which is varied for adaptation to gypsum.

Plaster hardened by Salts.—Boiled plaster, when mixed with a solution of alum, becomes remarkably hard, as shown by Elsner, (Verh. d. Gewerbv. in Preussen, 1843.) A solution of 1 pt. borax in 9 pts. water has the same effect (Keating.) Gay-Lussac observes that raw, unboiled plaster in fine powder becomes similarly hard when mixed with solutions of carbonate and bicarbonate, sulphate and bisulphate of potassa, and even caustic potassa. Soda salts, nitrate and muriate of potassa, are ineffective.

Artificial Marble.—Bouisson's patent is only for hardening plaster casts, by immersing them in a solution of alum, after being previously heated to about 84° for several hours. Elsner observes, from his experiments, that previous heating is wholly unnecessary.

Indurated Plaster.—Objects in plaster of Paris may be rendered like marble by coating them, one or more times, as may be necessary, with a liquid prepared as follows: 2 pts. of stearine and 2 pts. of Venitian soap are mixed with 20 to 30 pts. of cold solution of caustic potassa; and after a half-hours' ebullition, 1 pt. of pearlash is added, and the heat continued for a few minutes. Cold ley in sufficient quantity to produce perfect fluidity is then stirred in, and the liquid set aside for several days under cover. (Archiv. der Pharm. lvi.)

Artificial Silicious Stone.—Siemen's patent, taken out for this purpose, in Bavaria, in 1845 (Kunst u. Gewerbebl. 1847), makes silicious stone in the following manner: 100℔ of caustic soda in solution is evaporated to 80 quarts, and 1℔ silica added for every quart. The solution is effected under a pressure of 4–5 atmospheres. This solution, mixed with quartz sand, hardens to a stone which strikes fire with steel. For building-stone, millstones, &c. 1 pt. of the solution is mixed with 2 volumes of fine silica, and to the whole are added 10–15 pts. sand of different degrees of fineness, and sometimes 5–6 pts. coarse sand or gravel in addition. When the stones are air-dried, they are kept for several days in an apartment heated to 104°. They become quite hard in 5–6 days.

Asphalt, Mastic.—Asphalt pavements and floors have been successfully tried; roofs of an asphalt mastic have also been tried, and it is also proposed to employ it as a covering for bridges, roads, &c. (Lond. Journ. xxxvi.) The materials usually added to asphalt softened by heat are ground asphalt rock, limestone, sand, &c. Being put on a pavement or floor, in the softened state, the surface may be highly ornamented by inserting pieces or pebbles of various stones of different colors, producing designs in mosaic work, which, when well done, are said to be very durable. The experiment of such

foot-pavements in Philadelphia have not been very successful; probably owing to want of experience in those who constructed them, or possibly to some defect in the composition. In some instances, the asphalt covering is worn through in the course of a few years; in others, especially where exposed to the almost constant action of the summer's sun, the asphalt, becoming slightly softened, has been gradually pushed down the slope of the pavement, and appeared like a cascade of lava falling over the curbstone. An experiment made by J. C. Cresson, at the Philadelphia gas-works, some years since, with coal tar boiled down to pitch and thickened with sand, seemed to promise success. It was spread on a wooden floor, exposed to the weather and traversed frequently by carts, and yet showed few signs of complete abrasion, although subjected to so trying a test.

A Steam Cement.—An English cement of this kind, analyzed by Varrentrapp, consisted of 2 pts. litharge, 1 pt. fine sand, and 1 pt. fallen lime. After mixing the powder with oil or varnish, it should be used at once, as it soon becomes hard. It is used for stopping up joints in steam-engines.

III. METALLURGY.

Metallurgy embraces those chemical processes by which metals are extracted from their ores, as well as those by which the crude metal is refined or purified, and may be extended to embrace further operations which have in view the production of alloys, or other modifications, which still present the metallic character. The extension of chemical technology has evolved new processes for extracting metals from their ores, and for producing metallic surfaces and other effects, without the employment of fire, which was an element in former metallurgic processes. These processes being chiefly due to the employment of chemical agents, or the metals themselves in aqueous solution, a distinct branch of metallurgy has arisen, which we term hydrometallurgy, in distinction from the more ancient pyrometallurgy. We have thrown the metals into groups, dependent on their similar mode of occurrence or similar treatment, beginning with iron, which is the most important, and which is exclusively obtained by the reduction of its oxide. Fuel affords heat for breaking up chemical affinities already existing in the native compounds of the ores, and is at the same time the reducing agent for oxides. As ores are never found in a pure state, but always accompanied by foreign matter, this matter is removed by the addition of a flux, which fuses with the foreign matter to a glass or slag (cinder), and is then removed from the metal.

On ancient metallurgy and mining in Britain, see an article by J. Phillips, in Phil. Mag. April, 1849, and Amer. Journ. (2) viii. 96–102, 258–263.

Carbonic Oxide.—Filhol gives a convenient and economical method of obtaining this gas (Journ. de Pharm. et de Ch. viii. 99), which consists in gently warming a mixture of 1 pt. sugar or starch with 4 pts. by weight of oil of vitriol, and passing the generated gas through milk of lime or potassa, to absorb

carbonic and sulphurous acid. 20 grm. cane-sugar yield 2 litres gas, of which about $\frac{1}{3}$ is carbonic acid. We give this method of obtaining carbonic oxide, on account of its importance as a reducing agent, in order that experiments may be instituted with it.

1. Pyrometallurgy,

Or the operations upon metallic ores by fire.

Iron.—Wrightson's examinations of ores and iron from Staffordshire, and of the influence of the hot-blast, see in Chem. Gaz. vii. and viii. and Journ. Fr. Inst. (3) xvii. 201.

For one of the most able investigations into the operations of the blast furnace, by Bunsen and Playfair, see Journ. Fr. Inst. (3) xvii. 268, 338, 387; xviii. 24, 136, 218. On the manufacture of iron in South Wales, see Journ. Fr. Inst. (3) xix. 339.

Application of the Waste-gases of Blast-furnaces.—The masterly investigations of Bunsen on the working of blast-furnaces, above cited, have shown, that, under ordinary circumstances, $\frac{4}{5}$ of the heat produced is lost. The use of the waste-gases, proposed and executed in Germany, has been successfully carried out in Pennsylvania and other States, in many furnaces, especially where anthracite is employed, and, we believe, without serious detriment to the working of the furnace; therefore, with greater economy of fuel, where boilers and an engine are employed for blowing. Mr. S. Colwell, of Philadelphia, succeeded so perfectly in abstracting the waste-gases, that, while the furnace was fully charged and doing its usual work below, we have stood upon the charge with impunity, without feeling the heat or observing the stifling sensation of carbonic acid and other gases from the combustion. It is surprising, therefore, to observe that the experiments in Wales have turned out unfavorably, as reported in the Journ. Fr. Inst. (3) xx. 277, and we think the remarks of a collaborator just.

While on this point, we cannot forbear mentioning the white

deposit (often abundant) formed on the boilers and in the flues from the combustion of the waste-gases. A deposit of this kind, from the Conshohocken furnace of Mr. Colwell, was analyzed in the laboratory of one of us, by Mr. W. Fisher and Mr. J. Colwell, and proved to be almost wholly carbonate of potassa. From the Lebanon furnaces of the Messrs. Coleman, Mr. W. Fisher reports that the white deposit was chiefly sulphate and muriate of potassa. The quantities deposited may admit of their application in the saline arts.

Vanadium in Iron.—Deck and Wöhler (Ch. Gaz. vi. 298), who examined the refining slag of Staffordshire, which has the reputation of imparting ductility to iron when mixed with it, found that it contained silicate of vanadic acid with minute portions of molybdenum, chrome, and the usual quantities of silicates and of phosphoric acid.

Arsenic in Iron.—Schafhäutl has shown the almost constant presence of arsenic and phosphorus in cast-iron, steel, and bar-iron, and connects their observation with the late discovery of both these elements in mineral waters, their ochreous deposits and iron-ores. He attributes the quality of the Dannemora iron, and of the Low Moor iron (England) to their content of arsenic, and the quality of some Russia iron to its content of phosphorus. (Journ. f. Pr. Chem. xl. 304.)

Alkalimetric Test for Iron.—According to Marguerite (Technologiste, 1846), the iron is dissolved as protoxide, and converted into peroxide by a measured quantity of permanganate of potassa of known strength, and the total conversion is known by the liquid assuming a rose-red tint. The test liquid is obtained by fusing a mixture of 1 equiv. chlorate of potassa, 3 eq. caustic potassa, and 3 eq. binoxide of manganese, extracting with a little water, treatment with muriatic acid, until a violet-color appears, and then filtering through asbestus. 1 eq. permanganate of potassa is equal to 10 eq. protoxide of iron. The iron test-liquid is prepared by dissolving 1 grm. pure iron-wire in 20 cubic centimetres pure muriatic acid, diluting with 1 litre water and the permanganate dropped from a graduated tube until the liquid assumes a permanent rose-red

color. The number of measures used corresponds exactly to 1 gm. of iron. The iron-ore to be tested is dissolved in muriatic acid, and any peroxide it may contain is reduced to protoxide by adding crystallized sulphite of soda.

To this test it may be objected that it is difficult to prepare the permanganate with any degree of uniformity, and that if an excess of sulphate be added, the test-liquid would probably not indicate the amount of iron with exactness.

Carbon in Cast, Steel, and Bar-iron.—Karsten has endeavored to determine the limits in the amount of carbon, which separate cast-iron, steel, and bar-iron from each other, proceeding on the assumption that their characteristic properties are due to their content of carbon. He first determined the carbon in a single cast-iron by various methods, from which it appears that combustion with a mixture of chlorate of potassa and chromate of lead, or separation by chloride of copper or chloride of silver, yielded the best results. In the white iron from sparry ore, the amount of carbon was 5.586. When iron contains as little as 2.3 per cent. carbon, it still exhibits the properties of cast-iron, especially its precipitation of graphite (making gray iron) when cooled slowly. It is not forgeable when containing 2 per cent., and this property seems to begin with a percentage of 1.9, when it forms steel. The steel is not, however, capable of being welded, and is barely capable of it when the proportion is reduced to 1.75. A percentage of 1.4 to 1.5 indicates the maximum of combined strength and hardness. When the quantity is reduced to 0.5 it is a very soft steel, and forms the proper line of demarcation between steel and bar-iron. These limits are higher with a purer iron, and lower when it contains silicium, phosphorus, and sulphur.

On the *protection of iron from oxidation* by coating it, see Journ. Fr. Inst. (3) xix. 209.

Reduction of Iron-ores.—Sir F. C. Knowles' patent for reducing iron-ores consists in heating pure ores in retorts, and passing into them carbohydrogen from the coking of bituminous coal, or carbonic oxide from the combustion of coals. The

ore, when reduced, is transferred to and worked in puddling-furnaces. If steel be the object, the iron is suffered to remain in the retorts a longer time. Although there is every reason to believe that both bar-iron, steel, and cast-iron can be made in this manner, yet we may doubt the economical value of the project, except on a limited scale, for special purposes, and with the best ores. Iron must still be made by the older processes from poorer ores, which are much more abundant than the richer. For details of the patent, see Journ. Fr. Instit. (3) xx. 65.

Cast changed to Bar-iron.—Stirling's processes for the conversion of cast into bar-iron are deserving of consideration. To a given weight of cast-iron, about $\frac{1}{20}$ to $\frac{1}{5}$ as much scrap-iron is added, most conveniently by putting the scrap-iron into the hollows, which it is designed to fill by cast-iron run directly from a blast-furnace. The pigs are then puddled as usual, taking care that the whole be thoroughly melted. The stream of cast-iron may also be run upon the hearth of a reverberatory, containing scrap-iron, heated to a point below welding; the heat is raised until both are incorporated, and the metal is then run into a puddling-furnace. With better qualities of cast-iron, from $\frac{1}{10}$ to $\frac{1}{3}$ of scrap-iron may be used. In order to obtain a malleable iron, harder, less fibrous, and more granular than usual, $\frac{1}{2}$ or 1 per cent. of tin is added to the malleable iron mixtures above described. Bismuth, antimony, and arsenic will produce a similar effect. Such hard iron is said to work well, while hot, under the hammer, in the squeezer, between the rolls, and in the smithy. Zinc may be employed in the form of calamine. About the same quantity of copper also gives additional hardness to iron. Black oxide of manganese, in the proportion of $\frac{1}{2}$ to 1 per cent. of the mixed malleable iron, gives a more steely character to it, hardening the iron and facilitating the puddling process. (Rep. Pat. Inv. July, 1850.)

Bar made from Cast-iron.—Prof. Miller's (Ch. Gaz. vi.) analyses show that iron made by cementation contains more carbon than good bar-iron, but much less than it did before

this process. The decrease is not in the (graphitic) carbon insoluble in acids, but in the chemically combined portion.

Steel from Cast-iron.—The conversion of cast-iron into steel is desirable, if it can be effected rapidly and economically; for articles might be cast directly from a blast-furnace or a cupola, and then steeled to a greater or less depth, without altering their form, inasmuch as only a small quantity of carbon, a small percentage of the weight, is required to be removed. For a large number of purposes, this steeling need not proceed to a great depth, especially where toughness of body is not a requisite.

Attempts have been recently made to effect this decarbonization of cast-iron by burning off a part of the carbon in cast-iron, since it is known that the intermediate qualities of steel between bar and cast-iron are due to its intermediate state of carbonization. Riepe's process (Lond. Journ. Oct. 1850) is a modification of the process for decarbonizing cast-iron in a puddling-furnace by regulating the heat in the finishing process, and adding iron towards the latter part of the process. He also proposes imbedding cast-iron in clay and keeping it at the welding heat of steel, to effect the same purpose; and still further, the oxidation of castings by atmospheric air. The process of making malleable castings is also based on the same general principle. Such processes, as far as we know, can only produce inferior qualities of steel, although they may possibly produce a material having exactly the due quantity of carbon; for as the metal is subjected to a comparatively small amount of working, a considerable proportion of the impurities, silicium, phosphorus, sulphur, metals, &c. will remain in the mass and deteriorate the quality of the metal. The superior quality of steel is mainly due to a more or less perfect removal of injurious constituents, while, at the same time, much iron is oxidized and removed. By any of the processes yet known, it is impossible to avoid labor and loss of iron in making steel, and these seem to be in direct proportion to the quality of steel to be made. Late examinations by Miller of castings rendered malleable by cementation,

(Proc. Brit. Assoc. 1849, Amer. Journ. (2) vii. 276, and Journ. Fr. Inst. (3) xvii. 71), seemed to prove that not only carbon, but even silicium had been extracted. This startling assertion needs further investigation; for, should it be confirmed, the present modes of making bar-iron and steel may eventually give place to, or be modified by, processes of cementation.

Steel from Bar-iron.—It would be an important addition to the metallurgy of iron, if we possessed a rapid, economical, and efficient method of partially converting wrought-iron into steel; for iron may be more conveniently forged than cast into many forms, and, if they were then steeled externally, or at certain required points, would possess a core of tough metal with an exterior capable of being hardened. Hence, patents have issued and processes been proposed to effect this object; but we may conclude that the experiments have not been sucsessful, since they have not come into general use. Charcoal, mixed with a little borax, salammoniac and saltpeter, has been proposed (Lond. Journ. xxxvi. 26) as a material to imbed articles forged of iron. As prussiate of potash has a marked effect in converting iron into steel, a bed of charcoal imbued with a solution of the prussiate might answer the desired end. The greatest difficulty lies in limiting the depth of the transformation into steel, since the depth seems to depend on the length of cementation, so that large and small pieces cannot be cemented at the same time in the same bed.

2. *Copper.*—This metal, one of the next in value to iron, is chiefly furnished by Cornwall, England, where, as in most other localities, it occurs in the form of pyrites, or sulphuret of iron and copper. The same ore has recently been found at Perkiomen, on the Schuylkill River, near Philadelphia, in a good vein. The native copper formations at Lake Superior are truly gigantic; but if past experience be our guide, they will continue to yield profitably during a lengthened period of time, only when veins of pyrites shall have usurped the deposits of the native metal.

Copper and Arsenic, their general diffusion.—(Moniteur Industriel, 1846,—Dingler's Journ. ciii.) Walchner finds that

very small quantities of copper and arsenic are contained in all iron-ores, in ochres, ochreous deposits from springs, marls, and meteoric masses. It may be proved by dissolving them in pure muriatic acid, passing sulphuretted hydrogen through the solution to saturation, and suffering the precipitate to settle in a stoppered bottle. See also Buchner, Jr., on the content of arsenic, copper, and tin in the mineral waters of Bavaria. (Gelehrte Anzeigen d. K. B. Acad. d. Wissenschaften, No. 75,1847; Schafhäutl Untersuch. d. Eisenerze, Dingler's Journ. lxxiv. 303.)

Pelouze's Alkalimetric Test.—This method, both exact and rapid, depends upon the perfect precipitation of copper from its ammoniacal solution by sulphuret of sodium, and the exact point is indicated by the change from a deep-blue to a colorless solution.

One gramme of the substance to be tested is dissolved in 7–8 cubic centimetres of nitric acid, the solution diluted with water, and, after precipitating any silver that may be present with muriatic acid, treated with 20–25 cubic centimetres of caustic ammonia. A precipitate of lead or tin may be filtered off. 110 grms. of crystallized sulphuret of sodium are then dissolved in 1 litre water, and poured into a graduated alkalimetric tube. To a boiling solution of 1 grm. pure copper in nitric acid, treated with excess of ammonia, this test-liquor is added, carefully noting the number of measures required to decolorize the solution; suppose, 31 measures. Treat the solution of the substance to be tested, in a similar manner, and suppose it requires 30 measures to decolorize it. It contains, in this case, $\frac{30}{31}$ copper, of the quantity employed. That is, multiply the quantity of the substance to be tested (say 10, 20, or 100 grains) by the number of measures employed with pure copper, and divide by those employed for the other solution. Then, if 20 grs. had been used, multiply the quotient by 5, to bring the result to a percentage, &c. The test should always be performed with a boiling solution. The precipitate is $5CuS_2+CuO$. (See the Technologiste, Avril, 1846.)

New Method of Reduction from Copper-pyrites.—In Rivot and Philipps's method, the pyrites is roasted to oxidize the greater part of the sulphurets, the roasted ore fused in a reverberatory with silicious matters, lime, and fine coal, to convert the oxide of copper into a silicate,—and metallic copper precipitated from the fused mass by dipping in iron rods. After 3–4 hours the slag is said to retain only 0.4–0.6 of one per cent. copper, and the iron bars lost 1–6 kilogr. for 12–42 kilogr. of copper obtained. On this process, Elsner remarks that it is the method of precipitation long since adopted with lead-ores, and he corrects the chemical explanation. For in roasting such pyrites, part of the sulphur passes off as sulphurous acid, and part remains, forming sulphates of the oxides of iron and copper, mixed with some unaltered pyrites. In the subsequent fusion there is formed protosilicate of iron and lime, and copper-stone, or impure sulphuret of copper; from which last, the metallic iron precipitates copper while it is converted into sulphuret of iron. (For a detailed account of this method, see Journ. Fr. Inst. (3) xvii. 60.)

Fluxing.—Considerable difficulty being often experienced in fluxing refractory copper-ores, many substances have been proposed to facilitate their fluxion, such as sulphate or carbonate of baryta, to which a recent patent adds galena. (Lond. Journ. Oct. 1850.)

Extraction of Copper.—Mitchell, Alderson, and Warriner have patented a process (Ch. Gaz. vii.) for extracting copper from ores by one, or, at most, two roastings and fusions. It is applicable to sulphurets alone, or mixed with oxide, carbonate, and sulphate, or with sulphurets of other metals. The finely-powdered ore is calcined in a reverberatory furnace, and well stirred during the operation in order to promote oxidation. After cessation of sulphurous acid vapors, the heat is to be increased, but not high enough to agglutinate the mass. In this way all sulphate of copper, which may have been formed, is decomposed. If magnesia is present, the hot ore must be raked into water and leeched for the separation of magnesia salt.

The ore is now converted into regulus by fusion with lime and old slag, in a metal furnace; if the proportion of copper is less than 25 per cent., a second roasting of the ore is also advisable, previous to its treatment in the "metal" furnace.

The regulus is to be mixed with a quantity of sand equalling the amount of contained oxides of copper and iron; also with sufficient lime and old slag to promote fluxing. Charcoal—say one-tenth of the weight of sand and flux—is also added, and heat applied. After fusion, an additional portion of coal is well stirred in and the heat increased and continued for a short time. By this operation the silicate of copper, at first formed, is reduced, while the silicate of iron remains untouched.

It is doubtful whether, in working copper-ores, mixed to only 8 per cent., the metal can be extracted by these few operations without loss of copper; for, in the ordinary process, the sulphur left after roasting serves to collect the metal more perfectly from the slag.

Phosphorus in Copper.—Percy and James (Ch. Gaz. viii.) have given the results of a series of essays which go to prove that the presence of phosphorus in copper improves its sounding quality in casting; an effect also produced by small proportions of arsenic. They found that even as much as 2.4 per cent. of phosphorus did not impair the tenacity or malleability of the copper. It seems also to exert a protective influence against the corrosive action of sea-water.

Coating Iron with Copper.—Pomeroy's patent (Lond. Journ. Oct. 1850) proposes to make sheet-copper similar to sheet-tin, by which a stiffness is imparted to the copper, which is desirable in many processes of the arts. After cleansing the surface by acid-water and heat, the sheet-iron is dipped into water containing clay suspended in it, and then dried, when it is plunged for a moment of time into melted copper. The sheet metal may then be rolled. The chemical reason given for the use of a clay bath to protect the iron from oxidation, viz. the ammonia in the clay neutralizing the acid left on the iron from the acid bath,—is erroneous.

Action of Salt-water upon Copper.—Dr. Percy has determined by experiment (Athenæum 1849, Ch. Gaz. vii.), that the presence of phosphorus and iron in copper, even in the proportion of 2.41 of each in the 100 parts, scarcely impairs either its tenacity or malleability. Copper, alloyed with a little phosphorus, was also found to resist the action of salt-water much better than other specimens of copper.

			Grains.
Electrotype copper, after 9 months' immersion in sea-water, lost per sq. inch			1.4
Selected copper	"	"	1.1
Copper containing phosphorus	"	"	0.0
Copper from the "Frolic"	"	"	1.12
Dockyard Copper, No. 1	"	"	1.66
" " No. 2	"	"	3.0
" " No. 3	"	"	2.48
" " No. 4	"	"	2.33
Muntz's metal	"	"	0.95

3. *Lead.*—Nearly all the lead of commerce is obtained from galena, or sulphuret of lead. One of the most extensive formations of oxidized lead (carbonate) is in Mine à la Motte, Missouri, where millions of pounds of metal have been extracted from white-lead.

The total amount of lead-ore raised in Great Britain, in 1849, was 78,964 tons, which yielded 54,853 tons of metal; of this amount, England produced about three-fourths. The average yield of the ores of Great Britain is 69½ per cent.

Shot.—David Smith, of New York, has patented a plan for making shot in a comparatively low tower, by forcing or drawing an upward current of air through it, so that the descending shot will be brought in contact with as much cooling air in 50 feet as it ordinarily does in descending 150 feet or more.

Alkalimetric Test.—Domonté has described (Technologiste, 1846) a method of testing lead quantitatively, similar to that of Pelouze for copper (see above). The substance to be tested is dissolved in nitric acid, the solution, diluted with water,

treated with excess of potassa to redissolve oxide of lead, and then with a measured quantity of sulphuret of sodium solution, until all the lead is thrown down as sulphuret. The solution of sulphuret of sodium employed for the copper-test (30 cub. centimetres of which precipitate 1 grm. copper) is diluted with 3 times its volume of water for the lead-test. Tin, antimony, and arsenic have no influence in this reaction, as they are not precipitated by sulphuret of sodium from a strongly alkaline solution. Iron, nickel, and cobalt rarely occur in galena, and zinc is thrown down white after all the lead is precipitated. This test does not show the presence of bismuth, which precipitates with the lead and is estimated with it.

It may be remarked, that, although iron forms neither a frequent nor large constituent of good galena, yet it is frequently present, in quantity, in less pure ores of lead. But still the test may be used. For after solution of the lead in potassa, and decantation of the greater part, the residue may be diluted and filtered, leaving iron, nickel, and cobalt on the filter.—*J. C. B.*

4. *Tin.*—Thus far, mere traces of tin have been found in the United States, but its value in the arts leads us to wish that it may yet be discovered in workable quantities. It is associated in minute quantity with nearly all the rutile and tungsten found in the United States.—*J. C. B.*

Kersten has recently analyzed several kinds of tin; No. 1 from the Altenberg Zwitterstock, and No. 2 Peruvian.

	No. 1.	*No. 2.*
Tin	97.83	93.50
Lead	——	2.76
Iron	0.11	0.07
Insoluble in muriatic acid	1.90	3.76
	99.84	100.09

In No. 1, the portion soluble in acid was tin, iron, and a trace of manganese; the insoluble, bismuth and copper, with traces of arsenic, tungsten, and antimony. In No. 2, the

soluble was tin, iron, and lead; the insoluble, antimony, with traces of copper and arsenic. (Ding. Polytech. J. cviii. 25.)

Tin Plate.—Budy and Lammatsch propose alloying tin with $\frac{1}{16}$ of nickel, previously to coating sheet-iron with the alloy. The advantages contemplated are, greater hardness, and less fusibility, and the greater cost is said to be compensated by a saving of one-half of the quantity of tin usually employed. (An. Rep. Liebig and Kopp, ii. 278.

5. *Zinc, Mercury, and Arsenic.*—These three metals, being volatile, are obtained in a similar manner; the first two by distillation, and the last by sublimation.

The most important ore of zinc, hitherto worked, being calamine, both silicate and carbonate, it is mixed with lime to retain the silica and with carbon to reduce the oxide, and the mixture distilled in earthenware retorts. Blende, or the sulphuret of zinc, is abundant, but less easily and more rarely worked. The celebrated locality of red oxide of zinc and Franklinite, near Franklin, New Jersey, has attracted much attention at different times, and although the attempts to distil metal from it have been unsuccessful, it has recently been worked with renewed energy in order to manufacture the pigment zinc-white (see Metallosalines). Besides this locality of red zinc-ore, we also have a large formation of calamine in Pennsylvania, and it frequently accompanies the lead-ores of Illinois, &c.

Mercury occurs as a sulphuret, which is mixed with lime and distilled. A notable locality of the native cinnabar has been opened in California, but the superior attractions of gold-washing, or washing for gold, has prevented a fair development of the ore. The analysis of one specimen yielded upwards of 60 per cent. mercury, of another more than 30 per cent. The last was from an average of many pounds of ore. The ore presented a beautiful contrast of the red cinnabar with a white quartzose vein, and the cinnabar contained hydrated oxide of iron and bitumen.—*J. C. B.*

Purification of Mercury.—Ulex's method of purifying commercial quicksilver was formerly employed in Struve's

laboratory at Dresden (Archiv. d. Phar. xlvi. and Polytech. Centralbl. 1847). 2℔ mercury is rubbed for 10 minutes with $\frac{1}{2}$ oz. of a solution of perchloride of iron (sp. gr. 1.48) and $\frac{1}{2}$ oz. water, the iron solution washed off with water, and the mercury dried. If it contain more than 1 per cent. lead, the operation should be repeated. Perchloride of iron has the property of minutely dividing mercury, the iron being reduced to protochloride, and some subchloride of mercury being formed, which prevents the globules from reuniting. When other metals are present, they are more readily chlorinized than the mercury, and either washed away in solution or left as an insoluble powder. To test the purity of mercury, Ulex recommends shaking it in a clean glass tube, when, if impure, a black powder appears on the surface of the glass. In this manner $\frac{1}{40000}$ part of lead is shown. Elsner offers as a convenient but more costly method of preparing absolutely pure mercury, to warm a solution of corrosive sublimate (chloride of mercury) in an iron vessel with iron nails.

Mercury.—Violette (Comptes Rendus, 1850) has proposed a very convenient method of distilling mercury by high pressure steam. It consists in placing the amalgam or metal in a cast-iron cylinder to which is attached a worm. This latter serves as a heater for the water and also as a conduit for the generated steam, which, in traversing the interior of the cylinder, heats and volatilizes the contained metal. The vapors of metal and water, becoming involved, pass over in a double current into the refrigerator, where they are condensed and separate into strata.

This plan has the great advantages of economy as to time, fuel, and labor; all danger of concussion is obviated, and as there is no escape of vapor, the workmen suffer no injury to health, as is the case by the usual process.

Arsenic is associated with ores of cobalt, nickel, copper, &c., as arseniuret of those metals, and in the preliminary operations of roasting, it volatilizes as arsenious acid, and condenses in flues and chambers constructed for the purpose. It is then mixed with charcoal and sublimed as metal, or with

sulphur and sublimed as realgar or red sulphuret of arsenic. For its diffusion, see Copper, above.

6. *Antimony and Bismuth.*—These metals are obtained by eliquation, or by heating their ores when they flow out from the gangue. We have not yet found important localities of either of these metals, although antimony is inconveniently associated with some Western lead-ores. Bismuth, occurring mostly in the native state, is simply subjected to this operation; but antimony, being generally found as sulphuret, is eliquated as such, the sulphuret being very fusible. The metal or regulus of antimony is then obtained by heating the sulphuret with iron, alkali, &c. which take up its sulphur. As it is of some importance to have it free from arsenic, various processes have been devised to effect the separation, with variable success.

Antimony free from Arsenic.—To effect this separation according to Liebig's method, Bensch observes that the presence of sulphuret of iron is necessary, and gives the proportions: 100 pts. crude antimony (sulphuret), 42 pts. clean iron filings, 10 pts. anhydrous glauber's salt, 2 pts. charcoal, and 2 per cent. sulphuret of iron. After fusion, 16 pts. of the regulus, containing iron, 1 pt. sulphuret of antimony, and 2 pts. soda are kept in fusion an hour, and the regulus, freed from slag, is fused first with 1½ and then with 1 pt. soda (without sulphuret of antimony), each time for an hour, until the slag has a light-yellow color. The passage of the antimony through the crucible is prevented by smearing it previously with moist soda, and then heating it until the soda fuses and glazes the interior.

7. *Silver and Gold.*—We place these together, from their similar metallurgic treatment, both in the ore and when purified for commercial purposes. The methods of purifying are partly by fire and partly by acid; the modes of extraction from their ores are partly by washing, partly by amalgamation with mercury, and recently liquid methods have been proposed. Native gold generally contains silver, the greater part of which is to be separated, being lost by association with a metal of far greater value; and silver, when obtained from its ores, is

generally worked for the small fraction of gold it contains. Hence, both in extracting and refining, the mixed hydro and pyro-metallurgic processes are adopted.

The processes of separation or parting are by nitric or sulphuric acid. In the former case, the gold is melted with 2 or 3 times its weight of silver, granulated by pouring into water, and then treated with pure nitric acid, which extracts not only the silver added, but also more or less of that originally contained in the gold; for gold has such a covering power that acid could not extract the silver originally present, but by adding more silver, the gold is so disseminated, that as the silver is extracted, the gold is left in a spongy state. For parting by sulphuric acid, the gold is melted with more silver than for nitric acid, granulated, and then heated with undiluted oil of vitriol in vessels of platinum or iron, whereby silver and copper are extracted and the gold untouched. This method is especially applicable to silver containing only traces of gold.

The silver dissolved out from gold is recovered either by precipitating it in the metallic state by copper, or it is precipitated as a chloride by common salt, and the chloride reduced most conveniently and neatly by zinc and dilute acid.

Silver.—An important series of essays on this metal, by Malaguti and others, especially with reference to its extraction from the ore, has been presented to the "Academie des Sciences" of Paris, abstracts of which have appeared in the Comptes Rendus, Chemical Gazette, London Journal, &c. We refer to them for the details.

Reduction of Silver from its Ores.—A new method of effecting this is to roast the ores with common salt, which forms chloride of silver, and to lixiviate the roasted ore with a hot solution of common salt, which dissolves out the chloride of silver. The solution is precipitated by metallic copper.

According to another method, the sulphuretted ores are carefully roasted in a reverberatory, to change them into sulphates; the sulphates lixiviated by boiling water, and the silver precipitated by metallic copper.

Dr. Percy proposes to extract silver from its ores, in the wet way, by means of hyposulphite and chloride of lime. The details of the mode are given in a paper read before the British Association, Aug. 9, 1848. (Ch. Gaz. vii.)

Solubility of Chloride of Silver.—According to Pierre (Journ. de Pharm. (3) xii. 237), 1 pt. chloride of silver is soluble in 200 pts. strong chlorohydric acid, and in 600 pts. of the same acid, diluted with twice its weight of water.

Reduction of Chloride of Silver.—According to Hornung (Journ. de Chim. Médicale, 1847), moist chloride of silver is easily reduced by metallic copper and ammonia, very little ammonia being required for the purpose. The reduced silver is well washed with water and dried.

Kessler's method of obtaining chemically pure silver is as follows (Le Technologiste, 1847): Silver alloyed with copper or lead is dissolved in the least possible quantity of pure nitric acid, the solution diluted with 20 times as much water, and a solution of protacetate of iron added as long as a precipitate ensues. The latter is washed first with acetic acid, and then with water acidulated by sulphuric acid, until the wash-water ceases to show a precipitate with prussiate of potash. The precipitation of silver is so complete, that not a trace of it can be found by common salt in the filtered liquid. The protacetate of iron also precipitates platinum, especially by warming the solution. The surface of articles on which galvanic copper is to be precipitated, and which is not easily rendered conducting by graphite, may be rendered so by imbuing it with a solution of nitrate of silver and then treating it with protacetate of iron.

Wittstein (Buch *Rep.* vol. ii.) has compared the advantages of the various processes for reducing chloride of silver, and finds that with charcoal to be the safest and most economical. 2 pts. of chloride are mixed with 1 pt. of moist charcoal, the whole pressed into a black-lead crucible, loosely covered and heated. Calcination is continued until an half-hour beyond the cessation of hydrochloric vapor. When cold, the silver is extracted by nitric acid of 1.20, 3 pts. being required

for every 2 pts. of chloride. By heating the crucible more intensely, the silver will run together, and may be separated by mechanical means. The reducing power of the charcoal is owing to its content of hydrogen.

Levol dissolves sugar in potassa lye, and boils chloride of silver in it. The chloride is reduced to a gray metallic powder, while carbonic acid is evolved (Journ. de Chim. Méd.)

C. Zimmermann employs the following method for large quantities (Gewerbvereinsbl. der Prov. Preussen, 2 Jahrg. 1847). The washed chloride is mixed with water, pieces of bar-iron of the size of a finger thrown in, and the whole stirred with wood in a stoneware or porcelain vessel. 2℔ of iron are required for so much chloride as contains 8 marks of fine silver, and the reduction is completed in 2 hours. The washed and dried silver powder is fused in a clay crucible, with a mixture of equal parts of potash and dry salt.

This reduction is performed at the United States Mint, by granulated zinc and sulphuric acid, on about 1000℔ of silver per day, and presents advantages which the use of iron does not. There is not a great difference in the cost between clean bar-iron prepared as above, and granulated zinc, and, of the two, the latter is freer from injurious ingredients. As in the precipitation of silver from large *parting* (quartation) operations, the exact quantities of silver cannot readily be known; and as an excess of metal will be required to insure total and rapid reduction, this excess must be removed either by sulphuric acid or by sifting. The latter would be inconvenient, and the zinc is dissolved more rapidly than iron would be. Moreover, the reduction proceeds more rapidly with zinc, since it can be readily procured in a state of fine division by granulating. In melting the fine silver into toughened bars, we use saltpeter and borax. The silver thus obtained, without attempting to procure it very pure, shows a fineness of 995–997½, and may be easily refined in the pot to 998 and 999 thousandths.—*J. C. B.*

Parting by Sulphuric Acid.—Pettenkofer's experiments on parting gold by oil of vitriol are of some value. In this

process, gold may be extracted from silver, even when it forms an exceedingly minute proportion in the latter, by boiling it with oil of vitriol in iron or platinum vessels, and a large amount of gold has been thus recovered from old silver, since the process was first made known. To effect the parting most completely, there should be in 16 pts. alloy 3 to 4 pts. gold, and at least 10 of silver. Pettenkofer's experiments were made in the refinery at Munich, with Kronenthaler (crown-dollars), which contain $\frac{7}{100000}$ of gold. The parting is at first rapid until the fineness reaches 958 to 960 thousandths, when long-continued boiling (14 times) with great excess of acid raises it only to 970–972 thousandths, when it consists of 970 gold, 28 silver, and 2 platinum. No excess of acid nor repeated boiling will raise this spongy gold more than $\frac{1}{4}$ thousandth beyond this. It may, however, be refused with nitre, alloyed with silver, and again parted by oil of vitriol. It would appear, from his experiments, that the silver is alloyed in the metallic state with the spongy gold, and not combined with chlorine, phosphorus, nor arsenic; but it powerfully resists all attempts to extract it, whether by sulphuric or nitric acid. Sulphur may be distilled over it without its forming sulphuret of silver. Treated with boiling sulphuric acid to which bichromate of potassa has been added, a considerable amount of gold is dissolved, while sesquioxide of chrome is formed; but neither silver nor platinum, which is also present, is attacked. Pettenkofer thinks that the silver is in a different state from its normal condition. The silver may be extracted by fusion with bisulphate of potassa or soda. It is probable that the great preponderance of gold assimilates the alloyed silver to itself, just as silver alloyed with platinum renders the latter soluble in nitric acid, and as platinum in gold subjects the latter to more powerful corrosion by fusion with nitre.

Parting by Nitric Acid, or Quartation.—Pettenkofer confirms the results of Kandelhardt and Chaudet, that the ancient proportion of 3 silver to 1 gold is unnecessary, but that $2\frac{1}{2}$ silver to 1 gold is a far better proportion; for the gold retains

more silver when the former proportion is used, even with the use of strong acid and after continued boiling. He found further that only $1\frac{3}{4}$ silver to 1 gold was really necessary to obtain a correct separation. We employ 2 to 1 in the United States Mint.

Pettenkofer further observes that all commercial silver, not subjected to chemical separation, contains platinum. To prove the presence of platinum in parted gold, it is alloyed with $2-2\frac{1}{2}$ pts. silver, parted in the usual way by nitric acid, precipitated by dilute muriatic acid, filtered, the solution evaporated to dryness (at a gentle heat), the residue treated with alcohol, and the platinum precipitated from the solution by salammoniac. To determine it quantitatively, D'Arcet alloys two equal portions of the gold with silver, extracts one with nitric and the other with sulphuric acid; the excess of weight in the latter over the former is platinum.

Pettenkofer's discovery of platinum in the gold and silver is of some importance, for it serves to explain in part the refining effects of nitre on gold. By this fusion an appreciable quantity of gold is taken up by the nitre at the same time, although gold alone is slightly affected by it. After treating with water the slags resulting from toughening gold by nitre, the fine gray sediment contains alumina, silicic acid, potassa, oxides of iron, copper, lead, platinum, gold, and metallic gold.

Cleansing Silver.—It is said that silver or brass vessels may be cleansed by boiling them in water with calcined hartshorn in powder (30 grms. to 1 quart water), then drying them by the fire, and rubbing them when dry with woollen rags saturated with the above liquid and subsequently dried. The polish is heightened by further friction with a chamois-skin.

Gold.—For a full description of the Orange Grove or Vaucluse gold mine, in Virginia, see Amer. Journ. 2d ser. vii. 295, with analyses of the ore by *J. C. B.*

California Gold.—Of the following analyses, 1 is by Oswald; 2 by T. H. Henry, of the small flattened grains, spec. grav. 15.63; 3 by the same, of a larger piece with irregular surface and siliceous gangue, spec. grav. 15.96.

B.	1.	2.	3.
Gold	87.6	86.57	88.75
Silver	8.7	12.33	8.88
Copper	——	0.29	0.85
Iron	1.7	0.54	trace.
Silica	2.0	——	1.40
	100.0	99.73	99.88

California gold has a dark color, from its light coating of oxide of iron; but when fused, its light color indicates a large percentage of silver. The average fineness of California gold, as determined by some thousand assays at the United States Mint, Philadelphia, is 885 thousandths, or $88\frac{1}{2}$ per cent. pure gold, and 115th or $11\frac{1}{2}$ per cent. silver, omitting mere traces of other metals. For Iridosmin, see below.

The gold production of Russia in 1847 was about $17\frac{3}{4}$ millions of dollars, and supposing it to have increased 100 pounds per annum, it would amount to 20 millions in 1850. The produce of California may be estimated at 50 millions. These numbers being moderate estimates from known returns, the quantity of gold from the new sources of this metal in Russia and the United States was 70 millions, or more than 300,000 troy pounds, in 1850.

Extraction of Gold from Ores.—Allain and Bartenbach's process (Comptes Rendus, 1849) for extracting gold is applicable to all pyritous ores, even when the proportion of noble metal does not exceed two ten-thousandths. For working ore containing this quantity, the expense will be about $40 for every pound of gold obtained.

The ore, after being roasted in the air, is powdered, sieved, re-roasted into a red mass, made into paste with sulphuric acid of 66°, and again roasted until the entire cessation of sulphurous fumes. Sulphur, zinc, and copper are thus largely removed. The ore is now reduced to a still finer powder, boiled with dilute oil of vitriol, and the undissolved residue digested in a mixture of 6 pts. muriatic acid of 21° and 1 pt. nitric acid of 36°, diluted with water. Copper and gold are

then thrown down by iron, the precipitate calcined to oxidize the copper, which is to be dissolved out with muriatic or sulphuric acid.

A better method for pyritous ores is to roast them partially, if not already oxidized, and to melt them in a low blast-furnace, using a siliceous ore as a flux, if necessary. A large portion of oxide of iron will thus be removed, and the gold concentrated in the remaining sulphuret of iron, which could then be worked by dilute sulphuric acid.—*J. C. B.*

On the use of chloride of lime and hyposulphites, for extracting gold from its ores, see an essay by Percy, in Phil. Mag. 3 ser. xxxvi. 1–8.

Toughening Gold.—Wolff proposes, in the Practical Handbook for Jewellers, to fuse the brittle gold in a new crucible, and when melted to throw in one or two pieces of sulphur of the size of a pea, to shake the crucible a little with the tongs, and to cast it rapidly into a heated mould. He also proposes to render small pieces malleable by coating them with powdered borax, and heating them in the blowpipe flame until the surface commences fusion.

Both of these methods are resorted to at the United States Mint, but the choice of either depends upon the nature of the accompanying metals that give the gold its brittle character. When there is a quantity of iron present, the gold is fused with a mixture of sulphur, potash, and soda, which will remove it by making the very fusible mixture of sulphurets of iron and alkali. If tin, arsenic or antimony be present, a good flux is a mixture of borax, soda, and saltpeter, the last for oxidizing the foreign metals into their respective acids, the soda to give base to those acids, and the borax to collect the slag. In both these cases, a sand or clay crucible is preferable to a black-lead pot, in which last the graphite acts reducingly. Where lead is present, this process may partially effect its removal; but it is more completely effected during quartation and by washing the fine gold thoroughly with hot water, after extracting the silver by nitric acid. Another method of removing lead would be to fuse the gold with a little saltpeter,

borax, and silica, whereby a fusible slag of oxide of lead would result, and might be skimmed from the surface of the gold. Palladium and platinum, not unfrequently present in California gold, are likewise removed by the nitric acid in parting silver from gold. Grains of iridosmin have been observed in California gold, in distinct particles, even after three or more fusions, and seem to have no tendency whatever to enter into an alloy; but, while casting such gold, these particles collect at the bottom of the pot, from their greater specific gravity, and, by remelting in a small crucible, and carefully casting, they may be obtained mixed with a small quantity of gold. The latter is dissolved by nitromuriatic acid, and the iridosmin obtained pure.—*J. C. B.*

8. *Platinoid Metals.*—Platinum is associated with several other metals in the platinum sand which is found in some gold-districts. They have not been found as a distinct deposit in California, but have been observed in the United States Mint in the operations of assaying and parting. These associated metals are palladium, rhodium, iridium, and osmium, to which we must add the lately discovered metal, ruthenium. They have a sufficient resemblance to be classed together, and are obtained by a similar hydrometallurgic treatment. The grains of iridosmin, alluded to under gold, have been qualitatively examined and found to contain the new metal ruthenium, as was observed by Claus in relation to the iridosmin from other localities. Palladium has been observed, and at times in sufficient quantity to render the gold brittle. The quantities of platinoid metals found in the California gold are small, about $1\frac{1}{2}$lb of iridosmin having been obtained from about 25 tons of the gold, $\frac{3}{1000000}$, but the greater part has, of course, passed into the coin, the coarser grains only being left.—*J. C. B.*

Solution of Platinum Sand.—To dissolve it more readily, it is fused with 3 times its weight of zinc, and the brittle mass thus obtained is powdered and sifted. It is digested with dilute sulphuric acid to dissolve most of the zinc and iron, washed with water, and then boiled with nitric acid, which

dissolves iron, copper, lead, and palladium. The finely divided platinum in the residue is dissolved by nitromuriatic acid, avoiding an excess of muriatic, which would dissolve too much iridosmin. The usual method requires 8–10 times its weight of nitromuriatic acid. (Hess in Bullet. de l'Acad. de St. Petersbourg.)

Palladium.—According to Schmidt and Johnston, it is obtained from the gold-ores of Gongo Socco, Brazil, which contain gold, silver, palladium, copper, and iron, by dissolving in nitric acid, which leaves the gold, precipitating silver from the solution by common salt, and precipitating palladium and copper from the last filtrate by metallic zinc. These two metals are then dissolved in nitric acid and an excess of ammonia added, which precipitates the ammonia-palladium salt and holds the copper in solution. By igniting the palladium salt, metallic spongy palladium is obtained, which is condensed by a hydraulic press, and hammered like platinum. 6000 oz. of palladium have been thus extracted. On this method we would observe that, unless the gold contain a sufficient amount of the other metals, these metals cannot be fully extracted. Moreover, it is doubtful whether all of the copper would be extracted from the palladium salt by ammonia; and if pure palladium be required, it would probably be necessary to repeat the solution in nitric acid and separation by ammonia.

9. *Nickel and Cobalt.*—These metals being usually found together, and each impairing the other's qualities, they are separated chiefly by hydrometallurgic treatment, after concentration by calcination of their ores and fusion. They are usually combined with arsenic, but in Mine à la Motte, Missouri, they are either sulphurets or oxides. They are nowhere abundant. Traces of cobalt, sometimes amounting to 2 and 3 per cent., may be found in nearly all the ores of manganese.—*J. C. B.*

10. *Alloys.*—Most metals will fuse together and remain united while cooling, and sometimes the compounds offer properties intermediate between those of their constituents. Thus brass is intermediate in color and toughness between copper

and zinc; so gold and silver, or either of these, with copper. But, in some instances, the properties of the alloy are different; thus bronze, although intermediate in color between its constituents, copper and tin, presents an extraordinary combination of hardness and toughness. A small quantity of tin, lead, or zinc renders gold brittle. By alloying metals, therefore, we may obtain bodies which, for all practical purposes, are so many new metals.

Bronze.—The following table exhibits the composition of some ancient and modern bronze and bell-metal, according to recent analyses.

Title.	Copper.	Tin.	Lead.	Iron.	Gold.	Nickel.	Arsenic.	Analyst.
1. Ancient Attic bronze	88.46	10.04	1.50	...	...	...	...	A. Mitscherlich.
2. Athenian bronze, of the Roman period	76.41	7.05	16.54	...	...	...	...	Schmid.
3. Athenian bronze..	83.62	10.85	5.53	...	...	...	...	Wagner.
4. Coin of a Macedonian king	87.95	11.44	...	...	...	...	...	Monse.
5. Coin of Alexander the Great	95.96	3.28	0.76	...	trace.	...	...	Schmid.
6. Coin of Alexander the Great	86.76	10.24	2.31	...	trace.	...	...	Wagner.
7. Attic coin	87.89	11.58	...	0.27	...	...	...	Ulich.
8. "	88.81	9·61	...	1.18	...	...	...	Heldt.
9. Darmstadt chime, *B*, above first line	73.94	21.67	1.19	0.17	...	2.11	trace.	Heyl.
10. Darmstadt chime, *C*, treble clef	72.52	21.06	2.14	0.15	...	2.66	trace.	Heyl.

See an excellent article on the alloys of copper and tin, in Technologiste, and in the Lond. Journ. Oct. 1850.

Speculum Metal.—(Chinese metallic mirrors.)—Copper 80.836 + Lead 9.071 + antimony 8.43 = 98.337. It contained no trace of arsenic, exhibited a brilliant polish, and did not tarnish in the air. The presence of antimony is interesting, as it is not employed for metallic mirrors, and the above metals will probably be well adapted to the mirrors of telescopes.

German Silver.—The following table exhibits the composition of Chinese copper or Packfong, and of German silver, according to recent analyses.

	Copper.	Zinc.	Nickel.	Cobalt.	Iron.	Silver.	Sulphur.	Other Substances.	Spec. Grav.	Analyst.
1. Chinese copper or Packfong......	87.54	...	11.84	0.44	1.17	0.12	0.10	...	8.57	Onnen.
2. " "	85.09	...	9.49	1.16	4.08	0.14	0.49	...	7.84	"
3. " Red No. 1.........	98.49	...	1.19	...	0.01	0.14	...	...	8.31	"
4. " " 2.........	97.79	...	1.35	...	0.21	0.50	...	...	8.93	"
5. " " 3.........	82.21	17.56	0.71	...	0.19	0.07	...	...	8.70	"
6. " " 4.........	62.49	35.84	0.74	...	0.40	0.07	...	...	8.45	"
7. " " 5.........	97.12	...	1.84	...	1.28	...	0.30	...	8.58	"
8. " Blackish red......	92.65	...	2.11	...	0.10	...	0.06	Lead. 5.75	8.70	"
9. " "	98.48	...	0.46	...	4.43	...	0.47	...	8.46	"
10. English German-silver............	61.04	19.25	20.20	...	...	...	...	...	...	Elsner.
11. " "	65.24	19.52	13.00	12.00		2.05	...	...	...	"
12. " "	57.97	23.76	17.85	...	...	...	...	Tin. 0.14	...	"
13. Birmingham Eng. "	63.34	17.01	19.13	...	...	...	...	...	...	Louyet.
14. " "	62.40	22.15	15.05	...	...	...	...	...	...	"
15. " "	62.63	26.05	10.85	...	...	...	...	...	...	"

No. 10 was from Sheffield, England, and characterized by its silvery color and its great elasticity; No. 11 was termed

Chinese silver, and No. 12 exhibited a fine silver-color. Elsner ascribes the elasticity to the greater content of copper. Nos. 13, 14, and 15, analyzed by Louyet, were used in Birmingham for articles to be plated.

Malleable Brass.—Elsner (Newton's Journ.) has prepared malleable brass, by fusing together 60 pts. copper, and 40 pts. zinc. Great care is requisite in the heating, lest too much loss of zinc might ensue, and thus render the process unsuccessful. To obviate this difficulty, he advises the better plan of substituting a proportional mixture of brass for the zinc, and supplying the deficiency of copper.

This alloy is close-grained, of spec. grav. 8.44 at 50° F., very tough and malleable when heated. Its hardness = 4.

Tungsten and Copper.—Dr. Percy (Ch. Gaz. vi.), who made a series of experiments upon the subject, found that tungsten does not, as was anticipated from its peculiar nature, impart hardness to copper and protect it from oxidation. The essays with brass, German silver, and other metals, gave similar results.

Alloy for Bearings of Axles of Locomotives.—An alloy of 85 lead and 15 antimony is recommended to be cast in a box, and then greased in the usual way with soda, tallow, and palm oil. The part did not become warm, and the alloy prevented the lateral vibrations.

Alloys for Bearings of Rollers, Turning-lathes, Wagon-boxes, &c.—For heavy works, Tapp recommends 1℔ copper, 3½ oz. tin, and 4½ oz. lead. The copper is first fused, the tin next added, and lastly, the lead; and, before casting, the whole is well mixed. For smaller machinery with hand-power, the best alloy is 73 pts. tin, 18 pts. antimony, and 9 pts. copper.

Fenton recommends the following alloy as having proved serviceable for bearings on English railroads: 80 pts. zinc, 5½ pts. copper, and 14½ pts. tin. It is 40 per cent. cheaper than brass, may be fused in iron pots, and is a good alloy for cocks.

See a tabulated view of many alloys, employed in the arts, in different proportions, in the Polytech. Notizblatt, 1847, &c.

White, Malleable Alloy.—Parkes gives the two following proportions (Rep. of Pat. Inv. July 1845):

33lb zinc,	64lb tin,	$1\frac{1}{4}$lb iron,	$2\frac{1}{4}$lb copper.
50 "	48 "	1 "	3 "

The iron and copper are first fused together, the tin then added, and lastly the zinc. The flux consists of 1 pt. lime, 1 pt. fluor spar, and 3 pts. salammoniac. It is cast in sand or moulds. Another alloy consists of:

66 zinc,	$32\frac{1}{4}$ tin,	$3\frac{1}{4}$ antimony.
$79\frac{3}{4}$ "	$19\frac{1}{2}$ "	$2\frac{3}{4}$ "

It is fused with black flux, and, if used for sheathing ships, $\frac{1}{2}$ to 1 per cent. arsenic should be added. The alloy may be rolled cold into thin sheets.

Alloys for Dentists.—The following proportions are recommended:

	1.	2.	3.	4.	5.
Gold	1	1	1	–	6
Silver	–	1	1	1	–
Platinum	2	4	2	2	10
Palladium	–	–	–	–	8

The gold and silver are first fused, and the platinum and palladium then added. They are fused in small crucibles and require a blast. The solder for these alloys is either pure gold or an alloy of gold and silver. (Rep. of Pat. Inv. 1845, p. 72.)

Amalgam for Filling Teeth.—Pettenkofer (Ann. der Chem. und Pharm. 1849) has described an amalgam used by dentists. It is very hard, adhesive, and of a grayish color; and, owing to the very slight difference of density in the soft and hard state, it occupies the same space when cool as in the plastic state. This latter condition is given by heating the amalgam to nearly the boiling point of mercury, and then triturating it, for some time, in a mortar. After cooling, it is soft and readily worked either with the fingers or tools. In a few hours, it becomes intensely hard. The following is the best process for the preparation of this amalgam. Weigh out a quantity of pure mercury, dissolve it in a q. s. of hot sul-

phuric acid, and triturate the resulting paste of sulphate with pure, finely-divided copper, diffused in water at 140°–158°. There must be sufficient copper to form a composition of 70 pts. mercury and 30 pts. copper, or enough to reduce all the mercury salt employed, and to alloy the mercury eliminated. After rubbing for some time, the amalgam is to be well washed, pressed in a leather bag, and formed into small cakes for use.

Various Alloys.—Stirling forms an alloy of zinc and iron, by throwing a quantity of zinc into a cupola after the metal is run out and the blast stopped, whereby an alloy is formed with the iron still adhering to the sides, fuel, &c. When the alloy contains more than 7 per cent. iron, zinc is to be added to it; when less than 4 per cent., iron is to be added, the best alloy containing from 4 to 7 per cent. iron. This alloy is used for other alloys instead of zinc. An alloy of copper and manganese is made by adding to melted copper from $\frac{1}{2}$ to 2 per cent. of black oxide of manganese, or by mixing them beforehand and then melting, keeping the metal in either case covered with a reducing flux. A gold-colored alloy is produced by adding 1 pt. of the zinc alloy to 4 pts. of the copper alloy: it is very malleable and ductile, and takes a fine polish. The addition of $\frac{1}{2}$ per cent of tin hardens the gold alloy, although as much as 4 per cent. may be used. To prevent heating by friction, lead may be added to the alloy. An improved German silver is made by melting 10 pts. copper, 2 pts. nickel, and 6 pts. of the iron-zinc alloy; or 8 pts. copper, 2 pts. nickel, and 4 pts. of the iron-zinc alloy. A much larger proportion of iron-zinc renders the metal too hard for rolling, but good for some casting. An excess of copper spoils the color. The nickel and copper are first melted and the zinc alloy then introduced under cover of a reducing flux. (Rep. Pat. Inv. July, 1850.)

Fraudulent Gold.—When gold of 12 carats or less, is alloyed with zinc instead of silver, it still retains a true golden color, and this property has caused its extensive use in the manufacture of fraudulent jewelry. (Technologiste, 1847.)

Peruvian Gold Alloy.—According to How (Journ. Pract. Chem. xliii.), the Peruvian gold alloy consists of gold 38.93, silver 54.828, copper 5.80.

11.—A few operations on the metals, connected with the preceding subject, are here thrown together.

Metal Pipes and Tubes.—An improvement consists in the employment of machinery for ramming the moulds and cores, and a measured quantity of sand being pressed into each portion of the flask and between the converging sides of the divided core-box, and for forming a core by enveloping a metal rod in a coil of wire upon which the sand is compressed. (Lond. Journ. xxxviii. Aug.)

Cleaning Metal Castings.—To cleanse metal castings, they are usually thrown into water acidulated by sulphuric or muriatic acid; but as some metal is removed and the surface left rough, the process is objectionable. Thomas and Delisse found by their experiments that if several organic substances were added to the acid water, the scale of dirt and oxide was removed, but the surface of the metal unattacked. Elsner found that tar added to the acid water completely cleansed an iron casting, while another piece of casting in the usual acid water was nearly dissolved. (Technologiste. See also Journ. Fr. Inst. (3) xviii. 49.)

Enameled Iron.—After cleaning the surface to be enameled, the enamel is laid on as a paste and burned in under a muffle. F. Walton (Lond. Journ. Arts, 1847) uses three successive layers, which are as often heated in the muffle. The first coat is made by fritting 6 pts. pounded flint-glass, 3 pts. borax, 1 pt. red lead, and 1 pt. oxide of tin. One part of this frit, mixed with 2 pts. calcined and ground bones, is ground fine with water, spread over the metallic surface as a thick paste, dried, and then heated to redness in the muffle. The second coat is made of 32 pts. calcined and ground bones, 16 pts. kaolin, 14 pts. Cornish granite, and 8 pts. potash in solution: the paste thus made is fritted for 2–3 hours in a reverberatory and then powdered. Of this frit $5\frac{1}{2}$ pts. are mixed with 16 pts. coarsely-powdered flint-glass, $5\frac{1}{2}$ pts. calcined and ground

bones, and 3 pts. ignited and ground flints. The mixture is then ground with water, spread over the first coat and burned in. The third and last coat (which is similarly treated) consists of 12 pts. powdered feldspar, 4½ pts. kaolin, 18 pts. borax, 3 pts. saltpeter, 1½ pt. potash, and 1½ pt. oxide of tin.

Soldering Salt (chloride of zinc and ammonium).—Vessels may be tinned with this salt without previously cleansing their surfaces. It is made by dissolving 1℔ zinc in muriatic acid, adding 22 pts. salammoniac to the solution, and evaporating to dryness ; the yield is 2¼℔ of the double salt. To use it, the salt, moistened with water, is brushed on the surface to be tinned, a little solder laid on it here and there, and the surface heated until the solder fuses, when it flows wherever the salt was put, and unites with the metallic surface. (Journ. f. Buchdruckerk. 1847, No. vii.)

Tinning.—According to Becquerel, well-cleansed vessels of iron and copper may be tinned by dipping them into a solution of the double salt of chloride of tin and sodium, at a heat of 160° assisted by contact with zinc.

Soldering Wrought and Cast-iron.—Filings of soft cast-iron are melted with calcined borax, the mass pulverized and sprinkled on the parts to be united. They are then separately heated and welded together on an anvil by gentle blows. (Journ. Fr. Inst. (3) xviii. 50.)

Welding Powder.—To melted borax, $\frac{1}{10}$ salammoniac is added, the mixture poured on an iron plate, and an equal weight of quicklime ground up with it. Iron or steel to be welded is first heated to redness, the mixture laid on the welding surfaces, and the metal again heated, but far below the usual welding heat. The pieces unite firmly by hammering. (Lond. Builder, 1848.)

2. Hydrometallurgy

Embraces those processes performed by liquid agents on metals, by which they are procured again from combinations in the metallic state. Some of these operations are included

in Pyrometallurgy, as they constitute some of the necessary steps for extracting metals from their ores and purifying them. The present division embraces all other liquid metallurgic processes, especially the wide-spreading branch of galvanoplastics, together with etching metals and photography.

When we say that carbon is the great reducing agent employed in metallurgy, we refer to its exclusive use from time immemorial in furnaces, both as fuel and a reducing agent; but recent experiments have shown its reducing and decomposing power even in solution. Refer, also, to the third division of Chemics for its decomposing power.

Deoxidation by Carbon in the wet way.—Schonbein has ascertained that the persalts of iron and the salts of red oxide of mercury may be reduced, by agitating their solutions with finely powdered charcoal (as ignited lamp-black) to salts of protoxide of iron, and of the black oxide of mercury respectively.

On the reduction of salts of iron to the metallic state, see Journ. Fr. Inst. (3) xix. 354, and Chem. Gaz. April, 1850.

1. *Galvanoplastics.*—We have a few points to offer on the general subject of galvanoplastics, by which metals are precipitated in the metallic state by a galvanic arrangement, on surfaces previously rendered conductive. These processes, chiefly confined to gold and silver, are fast replacing the more ancient methods of plating, over which they possess great advantages, economy of time and material, convenience, facility for obtaining plating of any required thickness, &c.

Cyanides. Solution of metals in cyanide of potassium.—Elsner has described in the Journ. f. Pract. Chemie, vol. xxxvii. 1846, experiments on the solubility of various metals in cyanide of potassium, the general results of which he thus gives. He found that the metals employed might be divided into two groups: those which do not dissolve, as platinum, tin, and mercury, and those which dissolve. The latter are again divisible into two groups: those dissolving with the decomposition of water, as iron, copper, zinc, and nickel; and those unattended by the decomposition of water, as gold, silver, and

cadmium. Solution is effected in both cases by oxygen, but in one it is evolved from water, in the other extracted from the air. A part of the cyanide of potassium is oxidized to potassa (hydrogen escaping when water is decomposed), and the cyanogen, set free, unites with the metal; the metallic cyanide then forms a double salt with cyanide of potassium.

Oxide of Gold.—Figuier (Journ. de Pharm. 1847), who tested the several methods of preparing this oxide, now so extensively used in electro-gilding, has determined the best to be as follows. Dissolve 1 pt. gold in 4 pts. aqua regia, evaporate to dryness, redissolve in water, add a little aqua regia to take up the traces of metallic gold and of proto-chloride remaining undissolved. Evaporate again, redissolve in water, and mix with pure potassa perfectly free from chloride, until it gives an alkaline reaction with turmeric paper. Turbidity immediately ensues, when it is mixed with chloride of barium;—aurate of baryta precipitates as a yellow powder. When the precipitate begins to assume a whitish appearance, the addition of chloride of barium must be discontinued, as all the gold oxide has gone down and the alkali commenced to act upon the baryta of the chloride. The aurate of baryta is then to be washed until the waste-waters cease to be precipitated by sulphuric acid. The aurate is then heated to boiling, with dilute nitric acid, in order to eliminate the oxide of gold. By washing until the water no longer reddens litmus paper, the oxide becomes pure, and must be dried between the folds of bibulous paper by exposure to air.

Amalgamated Zinc.—Stoddard (Silliman's Journ. 1849) has recommended the following method of amalgamating zinc for cylinders for galvanic batteries. The zinc is heated to 450–500° and moistened with a solution of double chloride of zinc and ammonium, and mercury immediately dropped over the surface while still moist—the union is complete in a few seconds.

2. *Plating by Gold or Silver.*—Both galvanic and other methods are here included, as far as they have been recently improved.

Plating in the cold.—Stein (Polytec. Centralbl. 1847) mixes 1 pt. nitrate of silver and 3 pts. cyanide of potassium, adding sufficient water to make a thick paste, and rubs the mixture with a woollen rag upon a clean surface of copper, bronze, or brass. The process gives a bright silver surface, which, however, will not bear violent friction with chalk or tripoli.

Roseleur and Lavaux's method (Liebig and Kopp's Rep., and Technologiste, 1847) is the use of a bath of 100 pts. of sulphite of soda, containing 15 pts. of silver-salt. Neither of these processes yields very durable coatings.

Plating by dipping.—Levol employed solutions of cyanide of gold and of silver in cyanide of potassium, and articles of copper, bronze, and brass, to be gilt, were dipped into the boiling gold solution; but silver could not be gilt in this manner, and Levol proposed for it a solution of chloride of gold in sulphocyanide (rhodanide) of potassium. It was, however, shown that silver might be gilt in cyanide of gold and potassium, by wrapping it with zinc or copper wire, and then dipping it into the boiling-hot solution. Thus, to gild the inner surface of a silver cup, such wire is wound around the interior, and the boiling cyanide solution poured in. The zinc or copper renders the silver more strongly electronegative. A beautiful gilding is obtained by dissolving fine metallic gold in a solution of cyanide of potassium, and the metallic gold is obtained by precipitating its solution by copperas, or by imbuing rags with the solution and burning them to ashes. By warming the solution of cyanide of potassium with the latter, the gold is dissolved, and the solution filtered off from charcoal and ashes. Rags imbued with nitrate of silver, and burned, may be similarly used for making a solution of cyanide of silver and potassium.

Gilding in Elkington's Liquid.—Experiments in the Gewerbe-Institut of Berlin lead to the following proportions as the best for this liquid. Fine gold is dissolved in a sufficient quantity of aqua regia, evaporated to dryness at a gentle heat, and dissolved in 13 pts. water; 7 pts. bicarbonate of potassa

are added to the solution, which assumes a greenish color and becomes a little cloudy.

Barral (Mémoire sur la Précipitation de l'Or à l'État Métallique, Paris, 1846) gives his experiments; among others, the following. A bright article of silver, connected by copper wire with a piece of copper, which has been ignited and quenched in dilute sulphuric acid, is beautifully gilt, of any desired thickness, in the liquid. The bright article forms the negative, and the dull copper, the positive pole. Brought in contact with zinc, the silver is gilt more rapidly, and the action is strongest when the silver is connected with lead. The metal serving as positive pole is covered with a strong precipitate of pulverulent gold. By connecting copper with zinc, or iron with lead, the former is powerfully gilt. Bright copper is strongly gilt in connection with dull copper (ignited), while the latter is covered with a powdery deposit.

Gilding on Iron and Steel.—Elsner showed, in 1841, that steel pens may be heavily gilt, by first removing their blue coating by dilute muriatic acid, and then dipping them into a solution of chloride of gold rendered alkaline by carbonate of soda. Schöppler gives the following method for coating larger articles. (Polytech. Notizbl. 1847.) The surface of iron or steel, being brightened by the file, and coated with lack-varnish, those portions to be gilt are freed from the lacquer, etched by dilute sulphuric acid, dried, and dipped into a very dilute solution of blue vitriol until they are coated with copper. The metal is then dipped into a solution of 100 pts. gold in 13,000 pts. water, to which 370 pts. carbonate of soda are added. The gilding may be polished.

Fire-gilding of Wrought and Cast-iron, and Steel.—This operation, readily performed on bronze and copper by amalgamating their surface, has not been applied to iron, on account of the difficulty of amalgamating its surface; but R. Böttger has contrived the following good method of effecting it. A mixture is made in a porcelain vessel, of 12 pts. mercury, 1 pt. zinc, 2 pts. copperas, 12 pts. water, and 1½ pt. muriatic acid of spec. grav. 1.2. The article of iron or steel to be gilded

is introduced into this mixture, which is then heated to boiling, and in a short time is again withdrawn, covered by a shining coat of mercury. It is now ready to receive the amalgam of gold or silver for the purpose of fire-gilding (Pogg. Annal. 1846). The strongly positive zinc amalgam increases the electric tension between the positive iron and negative mercury, so as to cause their union.

Gilding Watch-wheels.—Ph. Plantamour prepares an amalgamating fluid for gilding wheels of watches, which, being alkaline, cleans and amalgamates the wheels at the same time, without injuring the steel pivots. Mercury is dissolved in an excess of nitric acid, and ammonia added to the solution until the precipitate at first formed is redissolved. The wheels being immersed in this solution, the ammonia dissolves fatty matters, with other impurities, from the surface, and the brass is amalgamated. While still moist, the wheels are covered with gold amalgam, put on a drum with holes for inserting the pivots, and gently heated over a spirit lamp, so that the quality of the steel is not impaired. (Comptes Rendus, xxiv. 784.)

Silvering Mirrors.—For Drayton's original process for silvering glass surfaces, see Lond. Journ. xxiv., or Journ. Fr. Inst. viii. 3 ser. His improvements in the same are in the Lond. Journ. for 1849, and Journ. Fr. Inst. 1850. One ounce ammonia, 2 oz. nitrate of silver, 3 oz. water, and 3 oz. spirit of wine are mixed together, allowed to stand for 3 or 4 hours, and then filtered. A quarter-ounce sugar (grape-sugar being preferred), dissolved in a half-pint of spirit of wine diluted with as much water, is added to each ounce of the filtered liquid, and this solution is employed for silvering, the article to be silvered being kept at 160°.

Meurer dissolves 5 grs. lunar caustic (nitrate of silver) in a little caustic ammonia, and adds to it a mixture of 1 drop oil of cinnamon, 2 drops oil of cloves, and 1–1½ drachms of absolute alcohol. The mixture becomes gradually cloudy, depositing a brown precipitate, which is filtered off, and the clear liquid poured upon a clean glass plate, surrounded with a rim. In the course of a few hours, it is covered with a

brilliant white coating of metallic silver. Elsner observes that it is necessary to let the liquid remain until all the brown sediment has separated, in order to avoid spots on the silver surface. Tourasse protects the back of the silver with varnish. The cost is said to be $\frac{1}{3}$ of that of the amalgamated tin, a very thin coating of silver being sufficient. Reichardt dissolves 1 oz. lunar caustic in 2 oz. water, adds $\frac{1}{2}$ oz. caustic ammonia, and 3 oz. strong alcohol containing 30 drops of oil of cassia, filters, and lets the whole stand 3–6 days. The liquid is poured on a glass plate cleaned by potash. He employs the oil of cloves in vapor, by dropping a little into a warmed vessel, which is turned a little to spread the oil, and is then inverted over the glass plate. The coating is made in $\frac{1}{4}$ hour.

Silvering glass by gun-cotton has been effected by Vohl, by dissolving the cotton in caustic potassa, adding a little of nitrate of silver, and then sufficient ammonia to redissolve the oxide of silver, while the whole is kept warm. The whole of the silver is precipitated as a brilliant coating on the sides of the vessel. Other analagous nitric compounds of sugar, manna, and gums produce a like result. (Technologiste, Lond. Journ. 1849, and Amer. Journ. (2) viii. 117.)

Speculums.—T. Fletcher's patent (Ch. Gaz. vi.) for making speculums, is to take a glass which has been silvered as for mirrors, and to coat the metallic side with a varnish composed of 2 oz. shellac, $\frac{1}{2}$ oz. lamp-black, and $\frac{1}{2}$ pint absolute alcohol as a protective against dampness and the action of acid. As the coating becomes dry, it is dusted over with finely-powdered plumbago, and the glass is then submitted to the electrotype process, by which means a thin coating of metal will be precipitated over the whole back.

Galvanic Gilding and Silvering.—(Communicated to Elsner by Mr. Brauns.)—Smee's battery is best adapted to the purpose, as it is simple in construction (consisting of platinized silver-foil, surrounded by an amalgamated sheet of zinc); requires only one liquid (1 pt. sulphuric acid to 8 pts. water); continues long in action, and gives off no gas during the operation. The cells consist of leaden vessels internally pitched. The

silver-foil is thus platinized: ½ oz. platinum is dissolved in nitromuriatic acid, evaporated to dryness, dissolved in 1 qt. rain water, 3–4 oz. oil of vitriol added. The silver-foil, having been dipped for a few moments in strong nitric acid, is hung on the cathode (zinc-pole), and platinum-foil on the anode (copper-pole) of a battery; the silver is covered with a gray coating of platinum.

The best silvering liquid is a solution of 1 pt. of the crystallized double salt, cyanide of silver and potassium, in 10 pts. water, to which ⅛ cyanide of potassium is added, and the whole boiled until it ceases to smell of ammonia. When the double salt alone is used, a platinum anode must be used, for a silver anode becomes coated with cyanide of silver, and impairs the conducting power. But the latter may be employed in the above liquid, because the cyanide of potassium dissolves the cyanide of silver and keeps the surface of the silver anode bright. The exhausted solutions are evaporated to dryness, and to the fusing residue a little saltpeter is gradually added to destroy cyanide of potassium.

The gilding liquid is thus prepared. 10 pts. gold are dissolved in nitromuriatic acid, diluted and filtered to remove the chloride of silver, 3 pts. common salt added, and the whole evaporated to dryness. The residue is dissolved in water, precipitated by an excess of ammonia, the yellowish-brown precipitate filtered, washed, and dissolved in a sufficient quantity of cyanide of potassium. An excess of this cyanide is then added, and the liquid is diluted with 64 pts. water. To destroy the cyanate of potassa, it is boiled until ammonia ceases to come off, and then 64 pts. more water are added. If the solution be warmed, the gilding is a beautiful matt. Exhausted gold solutions are evaporated to dryness and may be fused alone, or fused together with silver residues, and the silver extracted from the gold by nitric acid.

Galvanic Gilding.—Extracted from an essay by the Duke of Leuchtenberg, in the Bulletin de l'Acad., St. Petersburg, 1847. He draws attention to the special care required to precipitate gold above all other metals, and notices particularly

the following points. We must know the proportion, 1, of gold to the potassa-salts contained in the gold solution; 2, of the gilding surface to the strength of galvanic current, and the strength of the gold solution; 3, of the surface of the anode to the gilding surface, and to the content of gold in 1 decilitre-solution; 4, of the surface of the anode and of the gilding surface to the strength of the current.

The gold solution is thus made. 1 pt. gold is dissolved in aqua regia and evaporated (at a gentle heat) to dryness, the residue treated with an aqueous solution of 1 pt. caustic potassa, this mixture then with an aqueous solution of 2½ pts. cyanide of potassium, and 1 pt. caustic potassa, and the whole warmed and filtered.

He found that, for successful gilding, the above proportion between the gold and potassa in the solution should remain constant; and if (as when a platinum anode is used) the quantity of gold diminishes by precipitation, the force of the galvanic current must be increased by adding more cells, and increasing the surface of the anode, since this force is diminished in a dilute solution. The finest gilding is obtained when 1 decilitre of solution contains from 1 to ¼ gramme of gold. A reddish gilding is obtained by diminishing the galvanic force, such as lessening the number of cells, or the surface of the anode, or increasing the gilding surface.

Leuchtenberg rejects gold and silver anodes, because there is not as much of them dissolved as is precipitated on the cathode, and because they become coated with cyanides. He therefore employs a platinum anode, and determines the content of gold in solution, before and after gilding, by chemical analysis, in order to ascertain how much gold has been precipitated on the cathode. This is done by evaporating a decilitre to dryness, moistening with sulphuric acid, heating to redness, and extracting by water, when metallic gold remains.

In the galvanoplastic establishment of St. Petersburg, about 18 tons (363 ctr.) of copper are annually precipitated, 300 pud of silver, and about 60lb gold, thrown down in a month.

The gilding is begun in a solution containing 0.1 gm. gold in 1 decilitre of liquid, and finished in a solution not yet exhausted, whereby the beauty of the gilding is heightened. When the solutions have been too dilute, they are evaporated in an iron kettle to dryness, the residue fused in a crucible, and the salts washed out from the metallic gold. Coke-iron batteries are employed, and the electric current so regulated, that an evolution of gas may be perceptible at the anode, but not on the gilding surface. In the latter case, the current is diminished by removing some of the cells, by lessening the surface of the anode, or increasing that of the cathode (gilding surface).

Elsner justly remarks, on Leuchtenberg's method of analyzing the solutions to determine the quantity of gold or silver precipitated, that the practical gilder could not execute a fine assay of this kind, and that the simple method of weighing the gold or silver anode before and after use will give a sufficiently close determination of the amount of gold expended.

Matt Gilding and Silvering.—According to R. Böttger, a matt silvering is always obtained in a *boiling* solution of washed chloride of silver, dissolved in cyanide of potassium, by a moderate and constant electric current. A matt gilding is obtained in a boiling solution of ammonia-oxide of gold dissolved in cyanide of potassium, to which a small quantity of potassa has been added. The gilding is still finer when the articles have been previously matt-silvered. (Polytech. Notizbl. by R. Böttger, 1846.) See also Elsner's experiments on matt gilding with yellow prussiate of potash, in Verh. d. Gewerbfleisses f. Preussen, 1843.

Gold and Silver recovered from exhausted Cyanide Solutions.—To recover gold and silver from solutions of cyanide of potassium or yellow prussiate of potash, the solutions are evaporated to dryness, heated to redness, and extracted with water, when the metallic gold or silver will remain. Another method is pursued with a potassa solution of the prussiate. A silver solution is heated with muriatic acid under a draft (to carry off prussic acid), and the precipitated chloride well

washed. A gold solution is evaporated to dryness, the dry residue mixed with 1½ pts. saltpeter, projected portionwise into a red-hot crucible, extracted by water after cooling, the insoluble residue dissolved in nitromuriatic acid, diluted, and the gold precipitated as sulphuret by sulphuretted hydrogen; or after removing nitric acid from the solution by evaporation, and then diluting, it may be obtained purer by precipitation with copperas.

See, also, Berlin Gewerbe-Industrie u. Handelsblatt, Bd. 18.

Platinizing Glass, Porcelain, and Pottery.—Lüdersdorff gives the following method (Verh. d. Gewerbfl. in Preussen, 1847). A solution of platinum in aqua regia is evaporated to dryness, at a gentle heat, so that the residue appears reddish-yellow, and not brown, and is immediately dissolved in an equal weight of strong alcohol. 8 pts. of the solution are poured into 5 pts. oil of lavender, forming a clear brown liquid, containing platinum as protochloride. This solution is brushed upon the article to be platinized, and after drying burned in under a muffle. Glass and pottery is heated to low redness; porcelain to a bright red-heat. After cooling, the articles are rubbed with cotton and prepared chalk.

3. Various other metals and their compounds, beside the precious metals, have been employed for coating articles for various purposes, and we offer a few suggestions on these points.

Copper Precipitated.—In the usual method of precipitating copper from mine-waters by bars of iron, more iron is dissolved than necessary, as the water generally contains an excess of sulphuric acid, all the copper is not precipitated, and a portion of oxide of iron is lost from the subsequent exposure of the solution. Napier's improvement consists in acidulating the liquid with sulphuric acid, which keeps the surface clean for more energetic action, and in previously putting in saw-dust or other organic matter, which converts the persulphate present into protosulphate, so that all the iron is obtained as copperas. 1000 litres of such water are treated with 2 kilogr. sulphuric acid, and 2 kilogr. saw-dust (the last

being removed, when the peroxide is reduced to protoxide), and so much iron introduced as is chemically equivalent to the copper present in the water. In a few hours all the copper is thrown down, and the liquid, passed through a cloth to collect the copper, is evaporated to crystallize. (Rep. of Pat. Inv. 1845.)

Iron Coppered.—Reinsch has succeeded in giving to iron a durable and polishable coating of copper, by immersing it, after previous brightening by friction with cream of tartar and charcoal-dust, in a bath of hydrochloric acid diluted with 3 pts. of water, and containing a small portion of sulphate of copper. After being immersed a few minutes, the iron is removed, rubbed clean with a cloth, and again immersed. The supply of copper must be renewed after each immersion, and the immersion repeated until the coating is of the required thickness. (Jahrb. Pr. Pharm. xv. and Liebig and Kopp's Rep.)

Sulphuret of Copper, a coat for Copper Vessels.—R. Böttger describes a bluish-gray coating, which gives a fine appearance and protects from the weather. Dissolve 1 pt. of the crystallized sulphantimoniate of sodium (sulphuret of sodium and persulphuret of antimony) in 12 pts. water, heat to boiling, and dip the well-cleansed copper vessel for a few moments into the boiling solution. When the proper color is obtained, the vessel is removed, well washed, and dried by a cloth.

Coppering Glass, Porcelain, or Clay Vessels.—At the Exhibition of Manufactures, in Berlin and Paris, in 1844, there were vessels of glass, &c. coated with copper galvanically. Dr. Mohr published (Dingler's Journ. Bd. 103, p. 364) a process by which the coppering might be executed. He coated the vessel with copal varnish, rendered the surface conductive with gold-leaf, brass, or bronze-powder, and precipitated from a solution of blue vitriol. The work was well executed, except that, on heating a porcelain vessel thus coated, the copper was loosed from it in the form of the vessel. Dr. Elsner proposed another method (Verh., d. Gewerbver. f. Preussen, 1847), which was not subject to the same defect. The surface of the vessel was rendered matt or rough, by brushing on it

a thick paste of fluor-spar and oil of vitriol, exposing it for 24 hours to a temperature of 59° to 68°, and then washing it off with water. If the surface was not rough enough, the operation was repeated. The rough surface was rendered conductive by brushing on it well-ignited graphite powder, and then coppered by a Daniell's battery. Liquids were boiled in this vessel without loosening the copper coating. By coating a capsule with a varnish, bronzing it, precipitating copper on it, and then loosening the copper coating by heat, this copper vessel may be silvered or gilded, and found useful in the laboratory.

Galvanic Coppering.—For coppering smaller articles of iron, zinc, &c., a solution of cyanide of copper, dissolved in cyanide of potassium, is employed. The experiments of Rammelsberg (Pogg. Annal. vols. xxxviii. and xlii.) prove that two chemically distinct compounds exist, one consisting of 1 equiv. each of cyanide of potassium and cyanide of copper. the other of 3 equiv. cyanide of potassium, and 1 equiv. cyanide of copper. The former is difficultly soluble, crystallizes in needles, and, when treated with cold water, is resolved into white insoluble cyanide of copper: the latter is quite soluble and crystallizes in rhombs. Both salts are formed in the usual way of preparing the coppering liquid, which is made by adding cyanide of potassium to a solution of blue vitriol or verdigris, until the precipitate redissolves. For upon evaporating the solution, the needles crystallize out first, and then the more soluble rhombs.

According to Böttger's experiments, the soluble salt produces the finest coppering, and for ordinary purposes it is only necessary to digest copper-ash (a mixture of copper, oxide, and suboxide) with a concentrated solution of cyanide of potassium (1 pt. cyanide to 6 pts. water) for ½ an hour, at the temperature of 190°, to filter and dilute with an equal volume of water. To obtain the soluble salt, pure metallic copper (precipitated by zinc) is dissolved in a solution of cyanide of potassium. The oxides of copper give rise to the insoluble salt. (Polytech. Notizbl. by R. Böttger, 1846.)

For coppering larger vessels, the cyanide solutions are too expensive, and blue vitriol solution, acidulated with sulphuric acid, will be all-sufficient.—*Elsner.*

Antique Bronze, or Patina.—The following composition is said to produce the effect rapidly. 1 pt. salammoniac, 3 pts. powdered argal, and 3 pts. common salt, are dissolved in 12 pts. hot water, and 8 pts. of a solution of nitrate of copper added. (The strength of this solution is not given.—*Elsner.*) Newly made articles of bronze are coated several times with the above solution. A larger proportion of common salt gives a yellowish, and less gives a more bluish tint. (Polytech. Notizbl. 1846.)

C. Hoffmann produces a beautiful chrome-green brown, by first touching (not brushing) the surface of the bronze with a very dilute solution of nitrate of copper, containing a little common salt, brushing it off, then touching it with a solution of 1 pt. binoxalate of potassa, 4½ pts. salammoniac, and 94½ pts. vinegar, and again brushing it off. This operation is repeated several times. In the course of a week, the article has a greenish-brown hue, with a bluish-green tone in the depressions, and withstands the weather.

Elsner proposed a method, some years since, which produced an antique, almost identical with that produced naturally, on bronzes. The bronze article, with a clean surface, was dipped into dilute vinegar, and exposed for several weeks to a moist atmosphere of carbonic acid. The operation is economical, and easily executed. (Berlin. Gewerbe-Industrie u. Handelsbl. xii. 78.)

Bronzing and Brassing.—Brunnel, Bisson, and Gaugain, have given (Newton's Journ. 1848) a new process for brassing articles of iron, steel, lead, zinc, and their alloys with each other and with bismuth and antimony, by means of the following bath: 500 pts. carbonate of potassa, 20 pts. chloride of copper, 40 pts. sulphate of zinc, 250 pts. nitrate of ammonia. For bronzing, the zinc-salt is to be replaced by one of tin. The object to be plated, after being brightened by scouring, is connected with the negative pole of a Bunsen battery;—a

brass plate being the positive or decomposing pole. For large articles, the number, and not the size of the pairs must be increased. A coating of varnish is necessary to protect the plated surfaces from oxidation by exposure.

Salzedes's method (Ch. Gaz. vi. 227) is similar to the foregoing, but is more expensive, as it requires, in addition, the use of cyanide of potassium.

Lead: its Reduction in the wet way.—Sulphate of lead is a large secondary product in dyeing and other technical processes, and may be reduced, according to Trommsdorff, in the following manner. (Kunst u. Gewerbebl. d. k. Baiern, May, 1846, p. 330.) 10 pts. sulphate of lead and 1 pt. common salt are mixed with water to a paste, and bars of zinc immersed into the liquid. Grayish-black metallic lead is separated in a short time, and the solution contains sulphate and chloride of zinc. The lead is very pure. Bolley observes that the lead is left in a spongy state, and may be compressed into any required form.

Tinning and Leading Vessels of Copper or Iron.—According to Golfier Bessière, vessels of copper and iron may be easily and strongly coated with lead or tin, by employing soldering salt (chloride of tin and ammonium) instead of salammoniac, during the operation. It thoroughly cleanses the surface from rust.

Iron Leaded.—Parkes (Chem. Gaz. 1848) has given a new method for coating iron and steel with lead. The metal is to be scoured and dipped into a bath of 9 pts. of lead with 3 pts. antimony, or into one of 9 pts. lead, 1 pt. tin, and 1 pt. antimony, the surface of either of which must be covered with fused chloride of barium and chloride of sodium, or a mixture of both.

Galvanic Zincking—Kiepe made some experiments on this subject, under Dr. Elsner's direction, which resulted as follows. Wrought and cast-iron was readily coated with zinc, with the aid of a galvanic battery, by employing a solution of freshly-precipitated zinc in saturated sulphurous acid water, or a solution of the double salt of chloride of zinc and ammonium,

It is only necessary to use the zincking solution dilute, and the electric current proportionally feebler. The zinc coating had the thickness of writing paper. The results with hyposulphite of zinc were unsatisfactory.

4. The arts of design may be applied to metallic surfaces by etching, and in other ways, a few hints on which, of a chemical character, we here present.

Niello-work.—A metallic plate of iron, copper, &c. is covered with an etching ground, the design graved through it with a point, and these portions etched out by acid. The etching ground being removed, the plate is put into a galvanoplastic apparatus, and coated thickly with metal. The whole surface is ground down, until the precipitated metal is only left in the etched lines. Copper or silver is thus precipitated on steel or copper; and several metals may be precipitated on the same plate. (Vogel in Polytech. Notizbl. 1847.)

Etching on Copper and Steel.—To avoid the disagreeable nitrous fumes arising from the employment of nitric acid for etching, as is ordinarily done, Schwartz and Böhme propose for steel, 10 pts. fuming muriatic acid, diluted with 70 pts. water, mixed with a boiling solution of 2 pts. chlorate of potassa in 20 pts. water. The liquid is diluted, before using, with 100 to 200 pts. water. For copper, 2 pts. iodine and 5 pts. iodide of potassium are dissolved in 4 pts. water for a strong action, or in 8 pts. water for feebler action. (An. d. Ch. u. Pharm. lxvi. 63.)

Engraving upon Silvered or Gilded Copper.—Becquerel (Comptes Rendus, xxvi. 153) gives an abstract of Victor's method of copying drawings upon metal, glass, or paper; and also of Poiterin's ingenious improvement, by which these drawings may be transferred in a few hours to metal plates, so that they will furnish impressions. The process in detail may be found in the Philosophical Magazine for 1848.

The drawing or writing, previously subjected to the action of iodine vapors, is gently and carefully pressed upon a highly polished daguerreotype plate. The black lines, being the only portions which are iodized, imprint the silver with a corre-

sponding picture, by converting the parts impressed into iodide. The plate, thus prepared, is galvanized in a saturated solution of sulphate of copper, connected by a strip of platinum with the positive pole of a battery of several pairs. In this way, the white portions of the picture are metallized, while the iodized or black limnings remain untouched. The immersion of the plate in the copper solution should only continue some minutes; otherwise the whole of it may become coated.

After careful washing, solution of hyposulphite of soda is applied to dissolve out the iodide of silver covering the black parts, and the plate is then heated until its surface assumes a dark-brown shade. This oxidation of the copper protects the white portions of the picture, which it covers, from the action of the mercury next used to amalgamate the exposed silver. The amalgamated plate is overlaid with several layers of gold-foil, and then heated to volatilize the mercury. The lines originally engraved by the iodine are thus gilded, and, after the loose particles of foil are brushed off, the oxide of copper is removed by a solution of nitrate of silver, and both the copper and silver, beneath, dissolved out by nitric acid. As the gilded portions are protected, the etching may be managed to any depth. The plate thus engraved furnishes impressions in the same manner as wood-cuts.

The plate must be gilt instead of silvered, if it is to be engraved after the manner of copper-plates. The process is the same as above, excepting the omission of overlaying with gold-leaf, until the application of the nitric acid, which serves, instead of heat, to remove the amalgam, and simultaneously, also, the oxide of copper. In this kind of plate, however, the depressed portions furnish the black part of the proof.

5. *Photography*, the art of obtaining representations of objects upon surfaces rendered sensitive to the action of light, is already a beautiful art, although but in its infancy. Very correct representations of animate and inanimate objects, if at rest, are taken upon a polished surface of silver, upon paper, and lately upon glass. Some of the salts of silver, as iodide and bromide, are usually employed to render the surface sensi-

tive. Few improvements have been recently made in this art, but we hope to see most colors copied by photography, and to witness its more direct application to engraving by combination with the galvanotype.

According to Schönbein (Pogg. An. lxxiii.), starch-paste, mixed with freshly-made iodide of lead, so as to give it an intense yellow color, is the most susceptible of all substances to the influence of light.

Hyposulphite of Soda.—Faget's process for making the hyposulphite of soda (Journ. de Pharm. 1849) yields a more uniform and purer article than that obtained by the usual methods. It consists in boiling the neutral sulphite with sulphur, by which means nearly all the soda is converted into hyposulphite. The author prepares the neutral sulphite by mixing a solution of carbonate of soda with an equal volume of the same solution previously saturated with sulphurous acid gas. The resulting compound is an alkaline bisulphite, with an excess of sulphurous acid held in solution by the water of the liquid. After the entire expulsion of this excess of sulphurous acid by boiling, sulphur is added and the heat continued.

Plessy purifies this salt by melting it in its water of crystallization, evaporating slightly, and setting aside to cool. The hyposulphite crystallizes, and the impurities remain in the mother water.

For the preparation of hyposulphite of soda, see Lond. Journ. 1849, p. 129.

Iodine.—Niepce de St. Victor has discovered two properties of the vapor of iodine, which promise an extension of photography. The first property is, that it will deposit upon the lines of an engraving, whether executed with printer's ink, Indian ink, ink without gum, or red-lead. Before iodizing, it is better to pass the paper through ammonia, then through water acidulated with sulphuric, chlorohydric, or nitric acid, and dry it. The second property is, its depositing itself upon the projecting parts of embossed plates. (See Chevreul's Report on this subject, in Comptes Rendus, xxv. 785.)

Daguerreotype.—According to Belfield Lefèvre, and Foucault, an ordinary iodized silver plate, exposed to bromine vapor, until it assumes a dark purple tint, is less susceptible, but produces the lightest and darkest parts of the picture in complete detail. (Phil. Mag. xxx. 213.)

For various improvements in the Talbotype process, see Rep. Pat. Inv. for Aug. 1850.

Photographic Paper.—Blanquart-Evrard's method of preparing this paper is as follows (An. de Chim. et de Phys. xx.) To produce the negative picture, the best smooth letter-paper is laid for 1 minute upon the surface of a solution of 1 pt. nitrate of silver in 30 pts. water, taking care that no air-bubbles intervene. It is now removed, suffered to drain off, laid on a glass plate and suffered to dry. It is then passed into a solution of 25 pts. iodide of potassium, and 1 pt. bromide of potassium, in 560 pts. water, so that the surface covered with silver-salt is uppermost, and after remaining in it for 1½–2 minutes, it is taken out, washed in a large quantity of water, drained, laid on glass and dried. Before putting it into the camera, it is moistened on the first side with a solution of 6 pts. nitrate of silver, in 11 pts. crystallizable acetic acid, and 64 pts. water, and, after the action of light, with a saturated solution of gallic acid. The negative picture then appears.

The paper for the positive picture is laid for 2–3 minutes upon the surface of a solution of 3 pts. common salt in 10 pts. distilled water, carefully dried between blotting-paper, then passed for a few minutes through a solution of 1 pt. nitrate of silver in 6 pts. water, dried, and protected from light. The negative picture and the positive paper are laid together between two glass plates, exposed for some 20 minutes to sunlight, laid in water for some 15 minutes in a dark room, and then passed through a solution of 1 pt. hyposulphite of soda in 8 pts. water (containing also a little nitrate of silver). By the latter action, the white ground becomes clearer, and the red tints pass into a brown and lastly into black.

Horlsley prepares it thus. Fine paper is passed through a solution of 4 grm. common salt or salammoniac in 25 centi-

litres water, and dried between blotting-paper. Before use, it is brushed over with a solution of 2 grm. nitrate of silver, 0.3 grm. suberic acid, and 5 grm. caustic ammonia, dried, and put into the camera. After the lapse of 5–10 minutes, the paper is removed, washed in water containing a few drops of ammonia, then passed through a solution of 1 pt. hyposulphite of soda in 3 pts. water, dried partly between blotting-paper and lastly before a fire.

Archer (Chemist, 1850, p. 360, 450) has recommended the use of pyrogallic acid for developing the latent picture upon iodized paper. As disappointment is apt to ensue from the rapid decomposition of the acid, it is better to prepare the wash extemporaneously, as follows. To a solution of 20 gr. nitrate of silver in 1 oz. of strong acetic acid, add 3–4 gr. *pure* pyrogallic acid, immediately before using it. All risk of decomposition is thus avoided. The prepared paper is placed at once into the camera, where the light produces the picture without the necessity of a second washing. As the paper is very sensitive, the manipulations must be exact and dexterous in order to insure success. Ample directions are given in the original essays.

Blanquart-Evrard (Lond. Athenæum, 1850, 743) has proposed the employment of fluoride of potassium for imparting extreme sensibility to the iodized paper.

According to the same authority, when the paper is prepared by washing it with a liquor formed by mixing the white of two eggs with a pint and a half of whey, it is free from all inequalities, and may be kept an indefinite time without being injured. A little Narbonne honey added to the albumen, says Niepce de St. Victor, will increase the sensitiveness of the plate or paper.

Crayon Daguerreotype.—Mayall (Lond. Athenæum, 1850) gives the following directions for making the so-called crayon photographs:

"Take a daguerreotype image on a prepared plate, as usual, and be careful to mark the end of the plate on which the head is produced. Remove the plate from the holder before mercu-

rializing, and place it upon a sheet of glass prepared as follows. Cut a piece of thin plate-glass to the size of the daguerreotype, and affix to one side, with gum, a thin oval piece of blackened zinc, so that the centre of the oval shall correspond with the centre of the image upon the plate. Having carefully placed the glass, thus prepared, with the centre of the zinc disc upon the centre of the image, expose the whole to daylight for 20 seconds. The action of the light will obliterate all traces of the image from every part of the plate, except that which is covered with the blackened zinc. The thickness of the glass will also cause the action to be refracted under the edges of the zinc disc, and will soften into the dark parts. Mercurialize the plate as usual; the image will be found with a halo of light around it, gradually softening into the black ground, that will at once add a new charm to these interesting productions. By grinding the glass on which the disc is fixed, and by altering the size and shape of the disc, a variety of effects may be produced, which every ingenious operator can suggest for himself."

Photography on Glass.—See Niepce's communication in Comptes Rendus, and an extract from the same in Lond. Journ. Oct. 1850.

Photogenic Glasses.—Ceselli (Athenæum, 1850) gives the following direction for albumizing glass plates, so as to produce a perfectly uniform and smooth surface.

The requisite apparatus consists of a small rectangular box supported by three regulating screws. To its base is joined a movable plate of metal, which, being heated by a spirit lamp, communicates to all parts of the box an equal degree of heat. The plate is removed when the water-bath is to be used instead of the lamp. The apparatus is protected by a glass covering, to guard against heterogeneous bodies falling on the albumen. This cover is also movable; and the box being traversed by an internal channel, in this, when convenient, a thermometer may be introduced. A sliding frame receives the glass that is to be coated; this again being placed between two other plates of glass. The glasses are secured and their edges

brought to correspond by means of a tightening screw, so that the albumen, when either spreading or shrinking, may always cover the whole surface of the intermediate plate of glass. The frame is furnished on two parallel sides with a small groove to receive the albumen—which a small round-edged knife, elevated to the proper point by means of two spiral pivots cased in the sides of the box, and kept down in a parallel direction to the glass by means of a screw, serves to remove, thus producing the exact thickness of layer which is required. The frame is furnished along one of its sides with an indented ridge, to which a wheel provided with an external handle corresponds, so that the frame can be made to move with such velocity, as the operation may require.

IV. CHEMICS.

1. Salines,

Embracing the various alkaline salts, manufactured from common salt and potash, together with water, and the more important acids.

1. *Water and Solution.*—The character of a water, as to its fitness or unfitness for manufacturing purposes, is deserving of some attention. Thus, water derived from coal-mines is often so highly charged with free sulphuric acid, derived from the oxidation of pyrites in the coal, as to corrode a steam-boiler dangerously and rapidly; and, again, some waters deposit a sediment when boiled, which incrusts the interior of a boiler, and thus acts injuriously. The deposit generally consists of sulphate of lime, and many methods have been contrived to prevent its formation. One method is, to add salammoniac to the water which supplies the boiler, whereby the pan-stone is not formed.

Incrustations in boilers may be prevented in many cases by precipitating lime from solution in the water, kept in a tank, previously to its being run into boilers, and either allowing the precipitate to settle or running it through a filter of earth and sand.

Testing Water.—Dupasquier proposes to test water for an unusual amount of organic matter, by a few drops of chloride of gold solution. The usual quantity does not alter the yellow tint imparted by the gold even by boiling, but when more than usual, it passes through a brownish color to bluish and violet (Comptes Rendus, Avril, 1847). To test for bicarbonate of lime, he adds a few drops of a tincture of campeachy-wood, which changes to violet from the presence of this salt, or of

alkaline carbonates. To decide between these, a little blue-vitriol solution, added to the water, gives a bluish precipitate when bicarbonate of lime is present; in the same case, chloride of calcium gives no precipitate, but gives a milkiness or precipitate if alkaline carbonates are in solution.

Solution.—Salts being obtained and purified from solution, we may here allude to a general principle in the purification of these and other substances, organic or inorganic, and then to the decomposition of salts, &c., by filtration, especially filtration through charcoal. After a salt or other substance has been obtained from solution by crystallization, it retains a portion of other salts, either crystallized with it, or in the mother liquor, enclosed in cavities in the crystals. Although these impurities may in general be removed by repeated crystallization, yet the same end may often be attained more readily, by washing the crystals with a saturated solution of the same substance in a pure state; for being saturated, it will dissolve no more of that substance, but will dissolve portions of others. To effect this, the crystals to be washed should be small, either made so by disturbing the liquor during crystallization or by crushing. Thus salt, nitre, sugar, &c. are obtained pure by washing them respectively with saturated solutions of pure salt, nitre, sugar, &c.

The other point, of decomposition by charcoal, we have touched upon at the commencement of hydrometallurgy, where it was shown that a metallic oxide could be brought to a lower state of oxidation by carbon; but this is probably attended with the formation of carbonic acid, whereas in the instances to be cited, the porosity of the coal separates a substance from solution, and sunders a base more or less perfectly from its acid.

Morfit and Highway, in repeating Lebourdai's process for the preparation of alkaloids by means of animal charcoal, found that the bone-black used for decolorizing the solutions, always retained a portion of the precipitated alkaloid. They extended their investigations to the refuse black of chemical factories, and obtained from that which had been used in the

manufacture of sulphate of morphin, a considerable amount of the alkaloid. It therefore follows, that the use of bone-black as a decolorizing agent, is attended with loss, unless treated finally for the separation of matters which, by precipitation, have become incorporated with it.

Filtration through Bone-black and Charcoal.—The experiments on the extraction of substances from solution by bone-black and charcoal are interesting; those by Weppen, in An. der Chem. u. Pharm. lv. 241; by Chevalier, in Journ. f. Pr. Chem. xxxv. 356; by Warrington, in Phil. Mag. xxvii. 269; by Elsner, in Berl. Gewerbe u. Industrie-Blatt, xx. 295.

Weppen found that 30 gr. of bone-black, boiled with muriatic acid, thoroughly washed, dried, and gently ignited, extracted the following substances from their solutions: sulphates of copper, zinc, chrome and peroxide of iron, acetates of lead and peroxide of iron, nitrates of nickel, cobalt, silver, and of both oxides of mercury, tin salt, and tartar emetic. One grain of the salt was dissolved in ½ oz. water. A trace of the metal remains in solution, which no excess of the black can remove, while a basic salt is precipitated on it; but those oxides whose salts are soluble in ammonia are wholly precipitated. Oxide of lead, dissolved in potassa, is precipitated. Arsenious acid in aqueous solution is but slightly thrown down: iodine is removed from its solution in water. The sulphosalts of antimony and arsenic, dissolved in sulphide of ammonium, are separated as metallic sulphides by the black. It appears to exert no influence on alkaline and earthy salts.

Solutions of bitter extracts, as of wormwood, gentian, quassia, cascarilla, buck-bean, and colocynth, are rendered bitterless when the charcoal is in the proportion of 2 : 3; Columbo extract, by an equal weight of coal; aloes, by 13 times its weight; extract of galls and solution of pure tannin, by 10 times their weight. Infusion of Peruvian bark is also sweetened. Jalap and guaiacum are wholly precipitated from their solutions.

Chevallier found that oxide of lead is easily completely precipitated from its acetate and nitrate, but not from its muriate.

Warrington found that in decolorizing beer by charcoal, the hop-bitter was also removed; and that decoctions of Peruvian bark and solutions of sulphate of quinin, and acetates of morphin and strychnin, were freed from their bitter. 12 gr. bone-black were required for 2 gr. sulphate of quinin dissolved in 2 oz. water. An infusion of nux vomica was not debitterized by animal charcoal.

Elsner found that salicin was wholly removed from solution by filtration through common bone-black, as well as that freed from lime by muriatic acid; and that the coal digested with alcohol again yielded up its salicin. Strychnin, brucin, quinin, and cinchonin are removed from their hot aqueous solutions by bone-black or well-ignited wood-charcoal. A large excess of bone-black and charcoal sweetened a concentrated decoction of nux vomica. Solutions of aloes, lupulin, quassia are debitterized, and a solution of nitropicric (carbazotic) acid by bone-black freed from lime.

Weppen further observed that a charcoal which has been used for precipitating one metal, may still be used for precipitating another. Thus, 200 gr. coal, which had been used for precipitating a solution of corrosive sublimate, were shaken with a solution with 5 gr. blue-vitriol in 2½ oz. water, when in a short time only a trace of copper was left in the liquid, and disappeared altogether upon adding ammonia. After washing and drying the coal, it was shaken with a solution of 3 gr. copperas, from which it soon removed all traces of iron. (Journ. f. Pr. Chem. xxxix. 318.)

2. *Sulphur and Sulphuric Acid.*—This most important of all acids to the chemist, as the source of all others, is made by burning sulphur to sulphurous acid, and oxidizing this to sulphuric by nitric acid, or the oxides of nitrogen. Exclusive regulations of the Neapolitan government have developed the important fact that pyrites (sulphuret of iron) will answer the same end as sulphur on a manufacturing scale, and we know that pyrites is a very abundant mineral.

Sulphuric Acid.—Peligot observed, years ago, that sulphurous acid gas, passed through moderately strong nitric

acid, is oxidized into sulphuric acid, while nitric oxide is evolved ; and he proposed to burn sulphur alone without nitre, and pass the gas through the first crude acid containing nitric acid. Turner's patent is based on this fact (Rep. Pat. Inv. 1845). The lead chamber is made very low (3 ft. high), and its horizontal surface increased. The bottom is covered with crude acid of 1.5–1.6, containing 3–4 per cent. strong nitric acid. The sulphurous acid is drawn into the chamber by pumps, and in order to avoid loss, this acid and the nitric oxide are passed through three lead vessels, the two first containing the mixture of nitric and sulphuric acids, and the last sulphuric acid of 1.7. This process is said to yield 50 per cent. more oil of vitriol than the former method. (?)

Schneider (Comptes Rendus, xxv. 931) has succeeded in converting sulphurous into sulphuric acid, by means of pumice-stone peculiarly prepared, without the necessity of leaden chambers or iron retorts. We do not know how the pumice is prepared. A process was patented, many years since, for making oil of vitriol from sulphurous acid, by means of platinum-sponge, but was not successfully carried out as a manufacturing process.

Paul Gilbert Pretier has patented a process (Ch. Gaz. vi. 88) for making fuming sulphuric acid by distilling the bisulphates, as follows: Alkaline sulphates are placed in a stone retort, and acidulated by the addition of oil of vitriol. Heat being gradually applied, the distillate collected in receivers is clear and colorless.

Pure Sulphuric Acid.—A. A. Hayes (Silliman's Journ. 1848) takes the acid of 1.76 at that stage of the process for manufacturing the commercial article, when it is ready for transferring from the leaden evaporators to the concentrating vessels of platinum. This weak acid, while hot, is treated with nitrate of potassa, which renders it colorless by destroying the coloring matter. It also removes much of the hydrochloric acid, and converts the arsenious and sulphurous into arsenic and sulphuric acids. The remaining hyponitric acid is expelled by the addition of $\frac{1}{300}$ of sulphate of ammonia.

The acid is then concentrated to 1.78, run off into deep, leaden vessels, and gradually cooled to 32° F. After repose, the clear portion is transvased into shallow pans and cooled down to 0°, and left until one-half of its volume has solidified, when the congealed mass is to be separated and washed with pure acid. These crystals are freed from adhering portions of sulphates and arseniates of iron and lead, by fusion in glass vessels, re-crystallization, and washing with pure acid. To obtain a strong acid, the crystals must be melted and concentrated in a platinum kettle.

According to Wackenroder (Archiv. d. Pharm. (2) lviii. 28), the crystallized hydrate of sulphuric acid $SO_3 2HO$, used by Hayes as the source of his pure acid, may be readily obtained by congealing sulphuric acid, rectified over sulphate of potassa at 28.4° F. Very large rhombic crystals form and give, by fusion at 71°, a liquid acid of 1.784 at 46°. The acid thus prepared resolidifies at 39°.

Bineau has constructed the following table of composition of hydrated sulphuric acid, derived partly from his direct

A	B	At 32°		At 59°		A	B	At 32°		At 59°	
		C	D	C	D			C	D	C	D
5°	1.036	5.1	4.2	5.4	4.5	50°	1.530	61.4	50.1	62.6	51.1
10	1.075	10.3	8.4	10.9	8.9	51	1.546	62.9	51.3	63.9	52.2
15	1.116	15.5	12.7	16.3	13.3	52	1.563	64.4	52.6	65.4	53.4
20	1.161	21.2	17.3	22.4	18.3	53	1.580	65.9	53.8	66.9	54.6
25	1.209	27.2	22.2	28.3	23.1	54	1.597	67.4	55.0	68.4	55.8
30	1.262	33.6	27.4	34.8	28.4	55	1.615	68.9	56.2	70.0	57.1
33	1.296	37.6	30.7	38.9	31.8	56	1.634	70.5	57.5	71.6	58.4
35	1.320	40.4	33.0	41.6	34.0	57	1.652	72.1	58.8	73.2	59.7
36	1.332	41.7	34.1	43.0	35.1	58	1.671	73.6	60.1	74.7	61.0
37	1.345	43.1	35.2	44.3	36.2	59	1.691	75.2	61.4	76.3	62.3
38	1.357	44.5	36.3	45.5	37.2	60	1.711	76.9	62.8	78.0	63.6
39	1.370	45.9	37.5	46.9	38.3	61	1.732	78.6	64.2	79.8	65.1
40	1.383	47.3	38.6	48.4	39.5	62	1.753	80.4	65.7	81.7	66.7
41	1.397	48.7	39.7	49.9	40.7	63	1.774	82.4	67.2	83.9	68.5
42	1.410	50.0	40.8	51.2	41.8	64	1.796	84.6	69.0	86.3	70.4
43	1.424	51.4	41.9	52.5	42.9	65	1.819	87.4	71.3	89.5	73.0
44	1.438	52.8	43.1	54.0	44.1	65.5	1.830	89.1	72.7	91.8	74.9
45	1.453	54.3	44.3	55.4	45.2	65.8	1.837	90.4	73.8	94.5	77.1
46	1.468	55.7	45.5	56.9	46.4	66	1.842	91.3	74.5	100	81.6
47	1.483	57.1	46.6	58.2	47.5	66.2	1.846	92.5	75.5	"	"
48	1.498	58.5	47.8	59.6	48.7	66.4	1.852	95.0	77.5	"	"
49	1.514	60.0	49.0	61.1	50.0	66.6	1.857	100	81.6	"	"

determinations of spec. grav. and composition, and partly from calculation. The 1st column, A, represents Baumé's areometric degrees; the 2d, B, contains the specific gravity; the 3d, C, the percentage of oil of vitriol, and the 4th, D, the percentage of the anhydrous acid. (66° B. corresponds to spec. grav. 1.842). (An. de Ch. Phys. (3) xxiv. and xxvi.)

R. A. Tilghman, of Philadelphia, has patented several processes connected with salines, which possess the high merits of ingenious invention, simplicity of material and action, and the highest prospect of success. One of these processes is for obtaining sulphuric acid by the action of steam on the sulphates of baryta, strontia, or lime, at a high temperature. We refer for minutiæ to Rep. Pat. Inv. 1847. See also the soda manufacture.

Crystallized Sulphurous Acid.—Pierre (Comptes Rendus, 1848) obtained sulphurous acid in crystals, by passing the gas, previously washed, into water already surcharged with it. The temperature must not exceed 32°. In a few hours several hundred grains will have deposited. Its formula is $SO_2,9HO$. Döpping's acid, similarly obtained, has the composition (Bul. de St. Petersbourg, vii.) SO_2,HO.

3. *Common Salt and its derivative Arts.*—Beside its use as salt (for preserving animal matter, &c.), common salt is largely employed in the preparation of carbonate of soda (soda-ash), according to the invaluable process of Leblanc, by which muriatic acid is obtained at the same time. The soda manufacture is therefore most conveniently arranged under these two heads, making soda with its derived salts, and muriatic acid with its derivative arts. Salt is obtained from solid rock-salt formations, by evaporation of salt-springs or brines, or of the waters of the ocean. There is a locality of solid salt found in the United States, in the south-western part of Virginia: but all the salt used is either imported from Europe or obtained from brines. In making soda-ash, the salt is first converted into sulphate of soda by sulphuric acid, whereby muriatic acid gas is given off, and the salt-cake (dry sulphate of soda), mixed with carbon and carbonate of lime, is heated and extracted

with water. The solution contains soda, and a salt of lime remains.

A. *Soda-ash.*—Practice has advanced far before theory in this manufacture, for we knew but little of the theory of the changes effected during the process until within the last few years, although the manufacture has become so expanded that England produces annually more than 100,000 tons of carbonate of soda. The process has been recently investigated, with a practical object in view, by J. Brown (Phil. Mag. 3 ser. xxxiv.), and, for elucidating the theory, by Bodo Unger (Ann. Chem. Pharm. lxi. lxiii. lxvii.) The following are two analyses by Unger, the first of the crude soda, that is, after the mixture of salt-cake, limestone, and carbon have been duly heated; the second, of the residue, after the soluble salts have been extracted.

1. *Crude Soda.*

Sulphate of soda	1.99
Chloride of sodium	2.54
Carbonate of soda	23.57
Caustic soda	11.12
Carbonate of lime	12.90
Oxysulphide of calcium (3CaS,CaO)	34.76
Sulphide of iron	2.45
Silicate of magnesia	4.74
Coal	1.59
Sand	2.02
Water	2.10
	99.78

2. *Residue.*

Carbonate of lime	19.56
Oxysulphide of calcium	32.80
Sulphate of lime	3.69
Hyposulphite of lime	4.12
Hydrate of lime	4.02
Bisulphide of calcium	4.67
Sulphide of calcium	3.25

Hydrate of lime	6.67
Sulphide of sodium	1.78
Peroxide of iron	3.70
Silicate of magnesia	6.91
Coal	2.60
Sand	3.09
Water	3.45
	100.31

The results of Brown and Unger agree closely, when we consider how such materials are likely to vary in composition according to circumstances, but the amount of the carbonate of lime should be halved, as Brown proved it to be caustic lime, and the half added to the caustic soda, which would bring the total amount of carbonate of soda in the first analysis to nearly 40 per cent. Brown gives it at 35½.

The following table, from Brown, shows the composition of the different products of the soda manufacture.

	1.	2.	3.	4.	5.	6.	7.
Carbonate of soda	68.91	71.61	79.64	84.00	84.31	36.47	98.12
Hydrate of soda	14.43	11.23	2.71	1.06	trace.	0.94	1.08
Sulphate of soda	7.02	10.20	8.64	8.76	10.26	....	....
Sulphite of soda	2.23	1.11	1.24	trace.	trace.	....	....
Sulphide of sodium	1.31	....	trace.	....	....	....	....
Chloride of sodium	3.97	3.05	4.13	3.22	3.48	0.42	0.74
Soda-alumina	1.02	0.92	1.17	1.01	0.63	....	....
Silicate of soda	1.03	1.04	1.23	0.98	0.41	....	....
Insoluble and sand	0.81	0.31	0.97	0.71	0.25	....	....
Water	....	....	....	....	....	62.15	....

Analysis No. 1 is the salt obtained by evaporating the extract of the crude soda to dryness at 212°, and then heating in a calciner, which makes No. 2, soda-ash. Or, the extract is evaporated nearly dry, the mother-liquor drained off from the crystals; the dried residue, 3, is heated in a furnace, 4. By repeated solution, evaporation and calcination of the crystals, a better kind, 5, is produced, and by crystallizing the purer kind, *soda*, 6 results; and when this is calcined, the best product, 7, is obtained.

R. A. Tilghman applied the decomposing power of steam to

the decomposition of salt, starting from the simple equation $NaCl+HO=NaO+HCl$, that is, that water and salt, at a high heat, would mutually form caustic soda and chlorohydric acid. This decomposition does take place, but he found that by the assistance of alumina it was more perfect, the soda being retained by the alumina and the acid passing off. The soda is extracted by water from the alumina and the latter used again.

Tilghman also prepares Glauber's salt by heating to redness a mixture of common salt and gypsum, and passing steam through it, and then extracting by water. The Glauber's salt, mixed with alumina, is heated to redness, while steam is passed over it, and the soda then extracted from the alumina by water. (Rep. Pat. Inv. 1847.)

Testing Bicarbonate of Soda.—Chevalier (Liebig's Annalen, 1847) detects the presence of neutral carbonate in bicarbonate alkali, by adding starch-sugar to the aqueous solution of the latter, and heating. The mixture yellows or browns if any neutral carbonate is present.

The soda obtained from the soda-process is chiefly used for fluxing sand to make glass, for decomposing fats to make soap, or to neutralize acids. The boracic acid of the Tuscan lakes, neutralized by soda, yields the borax of commerce; and phosphoric acid, from bones, yields phosphate of soda, which is employed in dyeing and calico-printing.

B. The *muriatic acid* obtained as an incidental product in making soda-ash, besides its use for dissolving metallic oxides, is extensively employed in making bleaching salt. When muriatic acid is heated with black oxide of manganese, its hydrogen is oxidized to water by the oxygen of the oxide, and chlorine gas is set free. When this is passed into lime, chloride of lime or bleaching-salt is made, and passed for a long time into a solution of potash, the chlorate of potassa is formed.

Chloride of Lime.—According to Mène (Comptes Rendus, 1847), bleaching-salt may be made pure and expeditiously, by saturating slaked lime with water highly charged with chlorine.

The lime absorbs the chlorine as soon as it comes in contact with the solution; the supernatant water is immediately decanted and the application of chlorine liquor repeated, as above, several times. By exposure to a gentle heat for a short period, the moisture is driven off, and pure chloride of lime remains.

Chlorate of Potassa.—Calvert's process (Comptes Rendus, 1850) is to pass a current of chlorine gas through a hot (122°) mixture of 5½–6 equivalents of burnt lime and 1 equiv. caustic potassa in water. Chloride of calcium and chlorate of potassa are the products. When the solution is saturated with the gas, it is to be filtered, evaporated to dryness, redissolved in boiling water, and allowed to cool. The use of lime saves the great loss of potassa by other processes, 22 pts. of chlorate being obtained from every 10 pts. of potassa employed.

4. *Potash* is obtained by lixiviating the ashes of trees, evaporating the solution to dryness and calcining the residue. When purer, but more carbonated, it is termed pearlash.

New Source of Potash.—H. Wurtz has suggested a method of decomposing green sand, with the view of gaining its potash, by fusing it with chloride of calcium. See Amer. Journ. 2d ser. x. 326, where many experiments are detailed having the same object in view.

Potash tested for Soda.—Pagenstecher's method is as follows (Mittheil. d. Naturf. Gesellsch. in Bern, No. 65). It is based on the fact that a saturated solution of sulphate of potassa can dissolve large quantities of sulphate of soda. About half an ounce of the potash to be tested is poured over with water, treated with sulphuric acid until it has an acid reaction, evaporated to dryness, ignited, and weighed. The powdered saline mass is then treated with 6 times its weight of a concentrated solution of sulphate of potassa, stirred, allowed to settle, and the clear liquor drawn off from the sediment by a siphon. After being again treated with a like quantity of the sulphate of potassa solution, the residue is thrown on a balanced filter (the funnel covered with a glass plate during filtering to avoid evaporation), and when the last drops have

passed through, it is weighed moist, then dried at 212° and again weighed. The difference between the two last weights is the water of the solution of sulphate of potassa, which, being of a known strength, gives the quantity of sulphate of potassa it contained. This must of course be subtracted from the weight of the dried residue, and the remainder is the sulphate of potassa made from the pearlash. If the ash were free from soda, this weight would equal that of the original sulphate evaporated to dryness, but if less, then sulphate of soda has been washed out. From this loss (= L) the carbonate of soda in the ash may be thus calculated,

$$71\ (NaO,SO_3) : 53\ (NaO,CO_2) :: L : x \text{ or } x = \frac{L.53}{71}$$

It must however be observed, that the soda used to adulterate potash usually contains a large percentage of sulphate of soda.

Nitre is formed in artificial beds, or in some cases where nitrogenous organic matter is present, together with lime and some potash; but potash is usually added to the beds, or the extract of the soil, containing nitrate of lime, whereby nitrate of potassa is produced. Soda-saltpeter is obtained from Attacama in Peru. Both nitrates are the source of nitric acid.

Anhydrous Nitric Acid.—Deville (Comptes Rendus, 1849) has succeeded in obtaining anhydrous nitric acid by the action of absolutely dry chlorine upon nitrate of silver. It crystallizes in brilliant, colorless, six-sided prisms; melts at 85° F. and boils at 113°, and requires to be handled cautiously, owing to its tendency to explode.

5. *Alum.*—This most important salt to the dyer, calico-printer, tanner, and others, is sometimes observed in nature in an impure state, but it is generally procured from slates, which have originally contained iron pyrites (sulphuret of iron). The pyrites by oxidation form sulphuric acid, which is more or less transferred to the alumina of the slate; and to the extracted sulphate of alumina, sulphate of potassa is added and alum generated. As sulphate of iron is obtained incidentally in making alum, it leads us to the metallic salts and pigments, or metallosalines.

2. Metallosalines.

These embrace the preparation of various metallic salts, which are chiefly employed for dyes or making pigments. We may most conveniently divide the subject into the vitriols, or sulphates of iron, copper, zinc, and manganese, with the pigments derived from them; the salts and pigments of lead; the prussiates; the chromates, and a few others.

1. *Vitriols.*—Copperas, green vitriol, or protosulphate of iron, is made directly from sulphuric acid and scrap-iron, or from calcined pyrites, or is obtained in the kindred and connected manufacture of alum. These two articles are made on an extended scale in the United States, and but little can be offered that is new in relation to them.

Copperas.—It may be freed from lead and copper, and at the same time all peroxide of iron reduced to protoxide, by boiling its solution with good scrap-iron, nails, &c. until it becomes light and green. By evaporating the solution, it then yields bluish-green crystals. The precipitate will contain the copper, lead, &c. (Encycl. Zeitschr. d. Gewerbehandl. 1846.)

Preservation of Copperas.—According to Ruspini (Journ. de Chim. Méd. vi.) the protosulphate of iron, when in crystals, may be preserved from oxidation, by pressure, desiccation between the folds of bibulous paper, and, finally, efflorescence in a drying chamber at 86°. It is to be kept in well-stoppered bottles.

Oxidation of Copperas.—According to Wittstein (Buchner's Repert. i.) a solution of 1 pt. protosulphate of iron in 4 pts. water, after 11 months' exposure in a loosely covered vessel, deposits $2Fe_2O_3+3SO_3+8HO$, and not $2Fe_2O_3+SO_3$, as is generally admitted.

Sulphate of zinc, or white vitriol, is made directly from zinc and sulphuric acid. *Manganese vitriol* is made directly from black oxide of manganese and oil of vitriol, or it is obtained as a residue in making bleaching-salt from manganese, salt, and oil of vitriol. *Blue vitriol*, or sulphate of copper, is made

by the direct action of oil of vitriol and old sheet-copper, or by solution of precipitated hydrate of copper in the acid, or by lixiviating roasted copper-pyrites.

Pure Sulphate of Manganese.—Elsner thus prepares it: 1 pt. sulphur is well mixed and heated with $5\frac{1}{2}$ pts. binoxide of manganese, so that sulphurous acid escapes, and protoxide of manganese remains. When 2 equiv. of this oxide are treated with less than 2 equiv. of oil of vitriol, so that a portion of the oxide remains uncombined, this portion removes all the iron from the sulphate, and gives a good vitriol by solution and crystallization. White vitriol may be similarly made free from iron. (Elsner, in Hoffmann's Mittheilungen, &c.)

It would be better to use a little less sulphur, so as to leave a small part of the manganese in its state of binoxide, that by peroxidizing the iron the latter may be more effectually removed. A good proportion for a good ore (containing but little silica) is 1 pt. sulphur, 6 pts. black oxide of manganese, and 5 pts. oil of vitriol. The same principle has been applied to Epsom salt, by heating the solution with a portion of magnesia itself. It is also applicable to solutions of nickel and cobalt. But in all these cases it is necessary that the iron be in the state of sesquioxide, or be brought into this state.

Borate of Copper, a green Pigment.—16 pts. blue vitriol, and 25 pts. borax are separately dissolved in water, the solutions poured together, and the bluish-green precipitate, washed with *cold* water, is first dried at common temperature and then by warmth. The dried precipitate is then heated in a hessian crucible to a low red-heat, but not to fusion, and ground. Bolley proposes it for oil and porcelain painting (Bolley, Schweiz. Gewerbebl. 1847, 28). Dr. Elsner remarks that the color varies in different experiments, and that a certain degree of heat is requisite to its production.

Blue Sulphuret of Copper.—Alexander and Walter give the following method of preparing it (Buchner's Repert. d. Pharm. 1847). Black oxide is prepared by precipitating blue vitriol solution by caustic soda or potassa (lime ?), washing it well and drying it. A mixture of 2 pts. of this oxide, 2 pts.

flowers of sulphur, and 1 pt. salammoniac, is heated gently in a porcelain vessel, over coals, until the sulphur inflames; while burning, the mixture is stirred now and then, covered with a loosely-fitting cover, and removed from the fire for a few moments. A new portion of sulphur and salammoniac, without copper, is added, the cover replaced, and the vessel again heated. After some time the cover is removed, when much sulphur sublimes. As long as it shows a black and not a blue color, sulphur and salammoniac are added, and the vessel heated as before. When finished, it is washed with hot water, then with a little ammonia if oxide of copper be present, treated with caustic potassa or soda to remove the excess of sulphur, and, finally, washed with water, ground, and dried. Under a polishing tool it shows a beautiful steel-blue streak, and when mixed with size and brushed on paper, a steel-blue lustre on a violet-blue ground. In a medium of oil or varnish it is violet-blue.

The following simpler method was contrived in the Gewerbe-Institut of Berlin. Metallic copper is precipitated by zinc from a boiling solution of blue vitriol, and the fine powder washed and dried. 51 pts. of this copper, mixed with 3 pts. sulphur, are gently heated in a porcelain vessel, so that the excess of sulphur sublimes, but does not burn. When the heated mixture shows a sandy appearance it is finished, and, on cooling, shows a dark-blue color. The excess of sulphur is removed by potassa, and the residue well washed. If it have not acquired the desired tone, it is again warmed with sulphur, &c. It resists chemical action in a remarkable manner.

Winkelblech's method consists in rubbing together 1 equiv. lac sulphuris and 2 equiv. metallic copper, reduced from the oxide by hydrogen.

Zinc-white.—This pigment, to which attention is now drawn, is either the anhydrous oxide of zinc, or a hydrated oxide, or a hydrate-carbonate of the metal. It possesses a great degree of whiteness, about equal to that of white-lead; a sufficient body, and, what is of great importance, is less liable to tar-

nish than white-lead. Another important advantage cannot be overlooked: its freedom from the noxious character of carbonate of lead on those who employ it. It is less drying than white-lead colors, but in order to effect this result in a shorter time, dry sulphate of zinc (white vitriol) may be added to it, or a more drying oil may be employed. It has been too lately introduced to decide upon the relative merits of the several compounds above named, and it is even doubtful which can be produced at the cheapest rate; but it may be safely assumed, from its low equivalent (32.6, H=1), that a given weight of zinc will produce a much larger amount of white pigment than the same weight of lead, with an equiv. = 104. On the other hand, the objections to it are, that it has far less body (covering power) than white-lead, and that it requires a large amount of oil as its vehicle of conveyance to a surface.

Durability of Zinc-white.—Lassaigne drew attention, in 1821, to the use of oxide of zinc instead of white-lead as a pigment. He has lately stated that an oil-painting, finished with oxide of zinc, has remained of a pure white to this day. The oil was previously treated with sulphate of zinc to render it more drying.

Oxides of Zinc and Antimony, &c.—It has been an object of several patents, of late, to distil ores of zinc and antimony in such a manner that the volatilized and oxidized products, white oxides of antimony or zinc, shall be separately collected and used as pigments. To avoid the cost of first obtaining the metallic zinc and then converting it into oxide, the ores are heated in furnaces of various construction, but so arranged that the products of combustion from the mixed ore and fuel are conducted into condensing chambers, where both metal and oxide are obtained. Notwithstanding the ingenious contrivances for effecting this result, none have been yet found faultless. One of the late patents on this subject (Lond. Journ. Sept. 1850) subjects copper and other unroasted ores to the action of a blast-furnace, so that the non-volatile products are obtained in the furnace, while the volatile are condensed in chambers. In this manner oxides of zinc, antimony,

and arsenic, are obtained from copper and other ores. These mingled ores are hardly likely to yield the several products sufficiently separate and distinct.

Rochaz has a good arrangement for making this pigment direct from metallic zinc by combustion. (Lond. Journ. xxxvi. 1.) Fire-clay crucibles are set each in a furnace, so that the fire plays around but not above it. The zinc being thrown in and brought to ignition, the cover of the crucible is removed and a draft of air passes over the crucible, whereby oxide of zinc is produced, forming abundant white fumes, which are carried into a large chamber, divided into compartments. The greater part of the oxide settles in these; and to prevent any appreciable quantity from passing off, the last compartment is provided with hanging bands of hemp or other fabric, which may be multiplied without interfering with the draft. He proposes to use the Belgian furnace for distilling metallic zinc from its ores, consisting of a stack of many cylindrical retorts, in order to prepare the white oxide from the ore, and varying the arrangement so that the air is admitted to the distilling metal, whereby it is converted into oxide, and condenses in chambers. Several forms of blast-furnace have been proposed, but none have been proved sufficiently to speak of their merits.

The native oxide of zinc of New Jersey has been recently employed both for making the metal and zinc-white. The former is less likely to be economically produced than the latter; and it is stated that the process for the latter is eminently successful, as it requires but 2 pts. coal to obtain 1 pt. of the pigment. Judging from the experience in Europe, we must believe this to be a great miscalculation, for it requires some 11 tons fuel to make 1 ton zinc in Belgium and Silesia, and in making the oxide of zinc, the formation of metal must precede it.

A case of the peculiar effect of zinc in producing a colic among operatives engaged in making it, is reported in the Comptes Rendus, and although it appears to be less deleterious than white-lead, yet it shows that its effects on workmen must also be guarded against.

Compounds of Lead.—When metallic lead is calcined on the hearth of a reverberatory, to which the air has free access, it is converted into litharge, or simple oxide of lead; and when litharge is still further heated in a similar manner, it is converted into a higher oxide, red-lead or minium, or orange-mineral. Litharge, dissolved in vinegar, gives rise to acetate or sugar of lead. White-lead is usually made by putting a roll of sheet-lead into an earthen pot, containing a little vinegar in the bottom, and placing a large number of such pots in fermenting matter, manure, tan, &c. The fermenting matter evolves heat, steam, and carbonic acid, and the heat slowly evaporates the vinegar. This vapor induces the lead to oxidize and form acetate of lead, which is decomposed by carbonic acid as fast as formed, and the acid transferred to the adjoining stratum of metal. In this manner the sheet is corroded through, and becomes carbonate of lead, or white-lead. Various other processes have been proposed, but the old method still retains its place.

White-lead.—Gannal gives a method of preparing it from granulated lead by air and water. (Journ. Fr. Inst. 1847.) See a review of the different methods in Journ. Fr. Inst. 1842, vol. iii. 3d ser. p. 30.

Disbrow Rodgers's process (Ch. Gaz. 1850) for the manufacture of carbonate of lead, consists in exposing thin sheet-lead in a steam-heated chamber, to the joint action of acetic and aqueous vapors, and of carbonic acid gas, generated from fermenting matter contained in vessels beneath. The required temperature is 80° F., and the vinegar is volatilized by the admission of a current of steam. The chamber must be dark and air-tight, and the fermenting and acid liquors renewed six times during the process, at intervals of two days. The conversion of the lead is completed in two weeks. See Review, as above.

White-lead Pigment.—According to Patterson (Ch. Gaz. vii.), if a warm solution of chloride of lead is mixed with clean lime-water, in such proportions that one equivalent of the lead-salt may be made to react upon half an equivalent of

lime, all the lead is precipitated as $PbCl+PbO,HO$, at 212°, or $PbCl+PbO$ when dried between 212° and 350°. The great brilliancy and body of this white oxichloride induced the inventor to take a patent for its application as a pigment.

An excellent essay on the effects of preparing this pigment on the health of the operative, was made by M. Combes to the Academie des Sciences, and appears as a translation in the Lond. Journ. xxxvi. 184–193. We may state that in most of our establishments in the United States, the corroded sheets of lead are ground in water, whereby the greatest evils of the former mode of dry grinding are avoided.

3. *Prussiates.—Yellow Prussiate of Potash* is usually prepared by heating common pearlash or potash to fusion in an iron vessel, and adding to the melted mass, dried blood, horn-shavings, cracklings, &c. The excess of carbon in the animal matter probably reduces the potassium, while the nitrogen and carbon form cyanogen, which unites with the potassium. The formation of cyanogen, or rather of cyanide of potassium, from the nitrogen of the air, in part at least, was clearly shown by Bunsen, in his investigations on the blast-furnace. A patent had been taken out in England for making prussiate from the air and coal, but the process was not successfully carried out.

Possy and Bossière (Comptes Rendus, xxvi. 203) have succeeded in manufacturing yellow prussiate of potash, upon a large scale, by means of the nitrogen of the atmosphere. The daily product of their works, at Newcastle-upon-Tyne, is about 1000 kilogrammes (a ton), at a cost not exceeding 2000 francs ($400) for that quantity. The apparatus, as now constructed, will resist, for several years, the destructive action of the potassa and fire. It consists of a vertical cylinder set in refractory brick-work. The interior diameter of the cylinder is about 18 inches. The height, heated to bright redness, is about 10 feet. The cylinder, being heated to bright redness and charged with lumps of charcoal impregnated with 30 per cent of carbonate of potassa, is kept filled with burned air, which is injected, across a heated channel, by means of a forcing-

pump. In this way the treatment is to be continued for 10 hours, so that the whole mass may be acted upon. As the coal becomes cyanuretted, and is drawn off at the bottom, new supplies must be added at the top. The heated coal is conducted along an iron gutter into a reservoir containing powdered native carbonate of iron diffused in water. The coal becomes leeched, and the liquor on evaporation will yield crystals of prussiate.

Coke gives less product than charcoal; and the presence of even minute portions of water decomposes the cyanide and generates ammonia, thus decreasing the yield of salt.

Explosion with Red Prussiate of Potash.—During the preparation of red prussiate (ferridcyanide of iron) in a chemical work at Berlin, a violent explosion took place, without apparent cause, which dashed to pieces the wooden vessels in which the operation was performed, and shook the walls of the building. Fortunately no person was injured. The chlorine was generated in cast-iron vessels, from manganese, salt, and sulphuric acid. Muriatic acid was also evolved, which set prussic acid free from the prussiate solution. Now, an ammoniacal salt is produced by the action of chlorine on prussic acid; and by the further action of chlorine on ammonia, it is probable that the highly explosive chloride of nitrogen was produced. (Berlin. Gewerbe-Industrie und Handelsbl. xx. 141.)

Cyanide of Potassium.—C. Clemm (Annal. der Chem. u. Pharm. lxi. 250) gives the following details of Liebig's method, which should be observed to obtain a white and not dark-gray compound. Yellow prussiate of potash (ferrocyanide of potassium) is thoroughly dried by calcination. 8 pts. of this salt are intimately mixed with 3 pts. of fully dry carbonate of potassa in a covered iron crucible, and heated until the fused mass at a dull red-heat appears clear, and, when taken out in an iron spatula and cooled, appears white. The crucible is removed from the fire, gently struck to separate the iron, and its fluid contents (after evolution of gas has ceased) poured through a cullendered iron ladle (previously heated) into a

warm and deep vessel of silver, iron, porcelain, or stoneware, with a smooth inner surface. After cooling, the lower part of the fused mass, containing iron, may be cut off by a sharp tool. If the heat be carried to full redness, the resulting salt will have a gray color, from the separation of carbon through it.

To prepare cyanide for galvanic gilding or silvering, both the prussiate and carbonate of potash should be free from sulphate, as the consequent formation of sulphuret injures the color of both gilding and silvering.—*Elsner.*

4. *Chromates.*—Chrome yellow and other beautiful pigments and dyes are obtained from the mineral chromic iron, which is, in its purest form, FeO,Cr_2O_3, which should contain 68 per cent. of oxide of chrome. Mr. T. Garrett analyzed a specimen of the ore from Tyson's mine, Lancaster county, Pennsylvania, containing 63 per cent., which approached nearer to the formula than any published analysis. The ore at this and one or two other places forms solid veins or masses, but a great deal is obtained in the form of sand, by washing the sandy beds of the small streams flowing from a range of serpentine-rock.

B. Silliman, Jr., first observed that the green coating on the ore of Tyson's mine was a hydrocarbonate of nickel. T. Garrett found the same metal in some of the ore where the green coating had been carefully removed, and he has since proved that it contains a trace of tin. Garrett's analyses were performed in my laboratory, where he is still investigating some of the minerals of the chrome localities.—*J. C. B.*

Jacquelain's process (Dingler's Pol. Journ. cvi. 405) for the manufacture of potassa-chromate from the natural chromoferrite is as follows. The finely-powdered ore is to be intimately incorporated with chalk, and this mixture exposed in strata of 1½ inches, for 10 hours, to the heat of a reverberatory furnace. Neutral chromate of lime is thus formed, and the next step is to convert it into bisalt. This is to be done by grinding it, and, while suspended in water, adding a slight excess of sulphuric acid. To separate any protosulphate of

iron that may be present, milk of lime must be poured in and the whole left to repose. The clear supernatant liquor will, when drawn off, yield bichromate of potassa by double decomposition. This mode is said to be more economical, in time and expense, than the usual method with nitre and potash, but we must doubt its feasibility.

Tilghman's methods (Rep. Pat. Inv. 1847) differ materially from the foregoing. One requires the ignition of the chromoferrite with lime and powdered feldspar. The other proposes its mixture with 2 pts. lime and 2 pts. sulphate of potassa, and subsequent heating on a reverberatory hearth, in contact with aqueous vapor. For the details of the ingenious processes of this chemist, we refer to the original paper.

A new Metal in Chrome-ore.—Ullgren (Vetensk Acad. Förhand. 1850) has given an account of a substance noticed in the chrome iron of Röros, and which he considers a new metal. Its oxides bear a near analogy to those of iron.

Double Chromates.—Schneitzer (Journ. für Prac. Chem. xxxix.) has announced the existence of two double chromates. They are both of a beautiful yellow tint, and crystallizable. One, the chromate of potassa and magnesia, made by adding calcined magnesia to a strong solution of bichromate of potassa, heating and evaporating to crystallization, has the composition $2CrO_3,KO,MgO+2Aq$. The other, chromate of potassa and lime, has the formula $2CrO_3,KO,CaO+2Aq$.

Oxide of Chrome.—Barian (Berz. Jahresb. 1846, 177) prepares it by mixing 4 pts. bichromate of potassa with 1 pt. starch, igniting it in a hessian crucible, extracting carbonate of potassa by water, and again igniting the oxide of chrome. If the chrome salt had been free from sulphuric acid, the oxide will be a pure green. If it contain this acid, the salt is purified by crystallization. To test its presence, 1 pt. of the salt is dissolved in water with 3 pts. tartaric acid until carbonic acid ceases to escape, the solution treated with muriatic acid, and then tested with chloride of barium.

Wittstein's method is to ignite for ½ an hour 19 pts. bichromate of potassa and 4 pts. sulphur, to powder the mass

after cooling, and extract it with water. It yields $9\frac{1}{3}$ pts oxide of chrome. (Dingler's Journ. civ. 158.)

5. Some other pigments are prepared, partly by heat, as sulphuret of arsenic and ultramarine, and partly from solution, as sulphurets of cadmium and of antimony. Of these, we shall only notice the ultramarine, which, having been a valued pigment found in the mineral kingdom, was analyzed, and its composition imitated successfully. It is now made on a large scale, and of very different qualities in regard to color or durability.

Ultramarine, Artificial.—Recipes for the preparation of this beautiful blue color have been given by C. Brunner (Pogg. Annal. lxviii. 541–561); by Prückner (Journ. f. Prac. Chem. xxxiii. 257); Dr. Winterfield, in Polytech. Archiv. Mendelsohn, 6th year, 99, 260, 265, Berlin, 1842.

Brunner does not think that iron is necessary to produce the blue color, while Prückner and Winterfeld hold that iron is essential to the beauty of the color. Dr. Elsner, in a neat essay (Jour. f. Prac. Chem. xxiv. 385, &c.), showed that the color was due to a small content of sulphuret of sodium with sulphuret of iron, and that neither of these alone could produce it. Rolle, under Dr. E.'s direction, repeated many experiments, which strengthened his former conclusion that sulphuret of sodium and iron, though in minute quantity, are absolutely necessary to produce the color. Brunner states that the finest color is obtained by putting a thin layer of flowers of sulphur over a layer of the unfinished blue, and heating gently to volatilize the sulphur, but at the lowest heat required to burn it off. This is repeated 3 or 4 times. It increases 10–20 per cent. in weight. Elsner tried the effect of burning off sulphur repeatedly, but although the color was darkened, it did not improve its tone. Others tried it, with no more success.

3. Fine Chemicals and Pharmaceutics.

A large number of fine preparations are made, on a larger or smaller scale, for the use of the chemist and the physician,

and a few for the artisan. They are alkaline, earthy, and metallic compounds, metalloidal compounds, organic acids and alkaloids, &c. These may be conveniently divided into inorganic and organic.

1. *Inorganic Bodies.*—We find a few observations in reference to some of the metalloids, &c., which are here inserted.

Chlorine Preparation.—Over 1 pt. bichromate of potassa in a flask, pour 6 pts. muriatic acid of 1.16, and gently heat the mixture for a few seconds by a spirit lamp. A rapid action ensues, resulting in the evolution of chlorine and the formation of water, chlorides of chrome and potassium. (Amer. Journ. c. 491.)

Quantitative Determination.—Cottereau proposes for this purpose a solution of protochloride of tin (of known content) colored by sulphate of indigo, to which the chlorine-liquid is added until decolorization commences. From the volume of the latter employed, the quantity of chlorine is calculated. The free chlorine changes protochloride into perchloride of tin.

Iodine, its Extraction.—Pass sulphurous acid into a mineral water, or other liquid, containing iodine, until it has acquired a feeble odor of the same; then dissolve it in 1 pt. blue vitriol, and, after it, 1 pt. bisulphite of soda; white or rosy subiodide of copper will precipitate immediately by boiling, or in a short time by standing. If the precipitate be mixed with 2 equiv. binoxide of manganese and heated, iodine sublimes.

Chloride of Iodine.—Heeren recommends the use of chloride of iodine in photography instead of bromine compounds, which are more subject to alteration, and offers the following method of preparing it. 200 gr. dilute sulphuric acid (1 acid to 5 water) are poured over 100 gr. iodine, and dry chlorine gas passed through until the increase of weight is 66 gr. which must be accurately ascertained. The chlorine should be previously passed over chalk and chloride of calcium to remove water and muriatic acid from it; and the end of the tube conveying the gas should be about a $\frac{1}{2}$ inch above the surface of the liquid. The dark-orange liquid should be kept in a well-stoppered bottle, in a dark place. When used, 1 pt. of the

liquid is to be diluted with 32 pts. water, and will last for months.

Bromo and Iodohydric Acids.—Mène (Comptes Rendus, 1849) gives the following economical, easy, and safe process for making the bromohydric and iodohydric acids, which we take from Silliman, ix. 421.

6 pts. crystallized sulphite of soda are to be moistened with 1 pt. water, and 3 pts. bromine or iodine then added, and heat applied. The gases pass over pure, provided the neck of the retort be loosely plugged with asbestos, to intercept bromine or iodine vapors. The sulphite aids the bromine or iodine in the decomposition of the water, the latter taking the hydrogen, the sulphurous acid the oxygen.

Iodide of Potassium.—Criquelion's method (Journ. de Chem. Mèd. iv.) is to mix together, thoroughly, 40 pts. calcined lime slaked in water, and 14 pts. iron filings. To this mixture add, during constant stirring, and portionwise, 94 pts. iodine. When the liquid produces only an ochrey stain upon starched paper, it is to be filtered and washed, and the filtrate precipitated by carbonate of potassa. Filter, wash, and evaporate to crystallization.

According to Wackenroder, a small amount of sulphide may be found in iodide of potassium by the evolution of sulphohydrogen with protochloride of tin.

Iodide of Lead.—Huraut's experiments (Journ. de Pharm. 1849) upon the comparative advantages of the several methods of preparing iodide of lead, prove that the nitrate of lead and iodide of calcium afford the best results, both as to quality and quantity.

On the Nitrites.—Fischer, in a paper upon the nitrites (Pogg. Ann. lxxiv.), gives processes for the preparation of several. The potassa nitrite is made by heating the nitrate to redness, separating the nitrate by recrystallization, and the free potassa by acetic acid and alcohol.

Magnesian Lemonade.—Massignon prepares citrate of magnesia lemonade (Journ. de Pharm. xii.) by making 5 grm. carbonate of magnesia into a milk with water, pouring it into a

strong bottle, adding 7 grm. of crystallized citric acid, and corking quickly and firmly. Flavor may be imparted by means of different syrups.

Chromic Acid.—Traube recommends the following method of preparing chromic acid. (An. der Ch. u. Phar. lxvi.) To heat gently 1 pt. bichromate of potassa, 2½ pts. water, and 3½ pts. sulphuric acid, decant the liquid from the sulphate of potassa which separates on cooling, and add 4 pts. more of sulphuric acid when the acid begins to separate. The liquid is heated, water being added to dissolve the crystals, then evaporated until a pellicle forms, and set aside to crystallize. The acid, dried on brick or biscuit-ware, may be purified by carefully fusing it, when sulphuric acid and bichromate of potassa form an insoluble salt of oxide of chrome; or by re-solution in water, adding oil of vitriol until a precipitate appears, evaporation and slow crystallization.

Oxide of Antimony.—Hornung (Journ. de Pharm. 1848) gives the following economical process (a modification of Frederking's) for preparing the oxide of antimony to be used in the manufacture of tartar emetic. Mix together in an iron vessel 15 pts. finely-powdered sulphuret of antimony and 36 pts. sulphuric acid, expose to a gentle heat for 12 to 18 hours, and stir frequently. The mixture thickens at first, but afterwards liquefies upon an increase of the temperature, and finally becomes white; sulphur fuses and separates, and sulphurous acid fumes are disengaged. The heat and stirring are continued as long as these phenomena continue. When the vapor or gas evolved consists only of sulphuric acid, water is to be gradually added, and the mass washed for the removal of free sulphuric acid. The subsulphate of antimony is to be decomposed with carbonate of soda, and the resulting oxide of antimony washed. 13 pts. dry greenish-white oxide, soluble in tartaric acid, are thus obtained from 15 pts. sulphuret of antimony.

Sulphantimoniate of Sodium.—Van der Corput prepares this (Schlippe's) salt by intimately mixing together, in powder, 8 pts. effloresced sulphate of soda, 6 pts. sulphuret of an-

timony, and 3 pts. vegetable charcoal. This mixture is to be heated in a covered crucible, and when the fluid mass ceases to foam, it is to be boiled in a capsule with 1 pt. sulphur and q. s. of distilled water. The liquor, filtered and left to repose, deposits colorless crystals of $3NaS+SbS_5+18HC$. (Repert. der Pharm. 1848, and Chem. Gaz. vi. 268.)

Black Sulphuret of Mercury.—Vogler (Journ. de Pharm. 1848) prepares this salt more readily than by trituration, as follows. 4 oz. mercury are mixed with 1 oz. sublimed sulphur, washed and sieved, and the whole placed in a capacious glass vessel, and shaken for two hours. After this, another ounce of sulphur is added at intervals, and the agitation continued until every trace of mercury ceases to be visible to the eye. Two more ounces of sulphur are then added, and the mixture again shaken until the entire incorporation of the mercury with the sulphur, as may be ascertained by the aid of a lens.

2. *Organic Bodies.*—Some of the most interesting of these, to the pharmaceutist, are the alkaloids, and the volatile liquids chloroform and collodion.

Separation of Cinchonin from Quinin.—O. Henry's process (Journ. de Pharm. 1849) for determining the proportion of cinchonin in sulphate of quinin is based upon the difference in solubility, in cold water, of the acetates of the two alkaloids. 10 grm. of the mixed sulphates are mixed with 4 grm. acetate baryta, triturated with 60 grm. water, slightly acidulated with acetic acid, strained and filtered. Two volumes of alcohol of 35° are added to the filtrate, and then sulphuric acid in excess. After filtration, add ammonia, and boil: the cinchonin precipitates while the quinin remains in the alcoholic liquid.

Quinidin.—This new alkaloid, according to F. L. Winckler (Buch. Rep. xlviii. 385), occurs, with quinin, in one of the new barks most resembling Huamalies. It is crystallizable, soluble in alcohol, and slightly so in water. Its sulphate is so similar in appearance to the sulphate of quinin, that it is difficultly distinguishable from the former.

Quinoidin.—After preparing quinin and cinchonin from

Peruvian bark, a resinous mass, quinoidin, remains, which has been supposed to be a mixture of resin, &c. with quinin and cinchonin, or a modification of these alkaloids.

Roder (Mittheilungen des Schweizer Apothekervereins, i. 31) gives a method by which he obtained upwards of 40 per cent. of quinin, and 10 per cent. of cinchonin, from different samples of quinoidin. Of the residue, about 30 per cent. was resin. The process is as follows. A solution of a ½ pt. protochloride of tin, in 2 pts. water, is added to 4 pts. alcohol (.865) holding 1 pt. quinoidin: resin precipitates. Ammonia is poured into the decanted supernatant liquor, and the resulting precipitate drained, washed, dried, and exhausted with alcohol. The treatment is repeated with half the quantity of tin-salt first employed, and the clear liquids again precipitated by ammonia. The precipitates, washed, dried, and displaced as before, yield a tincture which, when neutralized with dilute sulphuric acid and evaporated, drops crystals of sulphate of quinin. The cinchonin remains in the filtrates from the tin and quinin precipitates.

Winckler (Journ. für Pract. Pharm. xv. 281) detects the presence of crystallized sulphates of quinin and cinchonin in quinoidin, by the use of hyposulphite of soda, which immediately precipitates hyposulphite of quinin, in a white crystalline form, and hyposulphate of cinchonin as four-sided needles, from their solution in hydrochloric acid. Both salts disengage sulphuretted hydrogen and sulphurous acid upon treatment with concentrated sulphuric acid. Dilute sulphuric acid converts them into sulphates, with evolution of sulphurous acid and elimination of sulphur. The amorphous alkaloids, or quinoidin, when saturated with muriatic acid, do not yield these precipitates. (Ch. Gaz. vi. 122.)

The Bark of Adansonia Digitata.—Dr. Duchassaing, a physician at Guadaloupe, employs this bark with great success in intermittent fevers. (Comptes Rendus, xxvi. and Ch. Gaz. vi.) It is without action upon the nervous system and improves the digestive powers. It is used in decoction made by boiling 1 oz. of bark in a litre of water, and evaporating to one-third;

and this quantity has served to cure even where quinin had failed. The bark is abundant in the French colony of Senegal.

Test for Opium.—Hensler (L'Union Medicale, 1848) proposes the following test for the presence of minute quantities of opium, founded upon the property of porphyroxin of being reddened when heated, by dilute muriatic acid. The suspected substance is to be mixed with a small portion of potassa and shaken with ether. Bibulous paper is to be moistened in this solution, and dried after each immersion. Dilute muriatic acid is then applied, and the paper exposed to the vapor of boiling water. If opium be present, the paper acquires a reddish-purple tint.

Papaverin.—This new alkaloid, discovered by Merck in opium, has the formula $C_{40}H_{21}NO_8$. It forms crystals insoluble in water, and more soluble in hot than in cold alcohol, and ether. Its salts are crystallizable. It is prepared by adding soda to a decoction of opium, treating the precipitate with alcohol, and evaporating the strained tincture to dryness. The residue is treated with dilute acid, the liquid filtered, and ammonia added. The resinous precipitate is then to be dissolved in dilute hydrochloric acid, and acetate of potassa added. The resinous precipitate thus thrown down, after having been washed with water, is then to be acted on with boiling ether, which, on cooling, drops the papaverin in crystals. (Liebig's Annalen, 1850.)

Strychnin.—Molyn (Journ. de Chim. Méd. 3) proposes the following method for making pure strychnin. 8 pounds of *nux vomica* are made into paste, with an equal weight of water, and left to repose, for 3 weeks, in a temperature of 68°–78°. The fermented mass is then pressed and exhausted by three several boilings with water, and the expressed liquids united and evaporated to 12 quarts. 9 oz. lime are next added, and after a repose of 6–8 hours, the mass is strained and pressed, and the resulting liquid treated with sulphuric acid to remove lime, filtered, and evaporated to 2 qts. and subjected to a second treatment as before, with 1 oz. lime. The precipitates, after the entire expulsion of all liquid by pressure, are to be dried,

powdered, and digested with alcohol of .935, which removes brucin and coloring matter, and then displaced with spirit of .838. This tincture, relieved of four-fifths of its alcohol by distillation, will drop strychnin in granules, which may be rendered perfectly pure by washing in alcohol of .935 and recrystallization.

Thein.—Heijnsius (Scheidk. Onderzoek, and Ch. Gaz. viii.) recommends an easy method for preparing thein by sublimation. For this purpose, damaged tea is placed in an iron pot, covered with filtering-paper, and surmounted by a paper cylindric cap. Cautious application of heat insures the success of the operation.

Oenanthin.—A resinous principle, obtained by Gerding (Journ. f. Prac. Chem. 1848) from the plant *Oenanthe fistulosa.* Its effect upon the system is very decided and powerful, producing hoarseness and even vomiting, when taken in the dose of a half to one grain.

Cedron.—This remarkable substance is, according to Hooker (Lond. Pharm. Journ. x. 344), the cotyledon of the seed of the *Simaba Cedron*, a plant indigenous to Panama, New Grenada. The seed, as well as the bark and wood, are bitter and tonic. So highly is it esteemed by the natives, as an antidote for bites of venomous reptiles, and as a specific in intermittents and diseases of the stomach generally, that it commands, frequently, an enormous price. Herran (Comptes Rendus, 1850), who administered it in eight cases, attests its efficacy. He gave it in doses of 5 or 6 gr., mixed with a spoonful of brandy, and at the same time dressed the bitten part with linen saturated with some of the spirituous liquor. After repose, the patient recovered without any repetition of the dose. A similar treatment was equally successful in cases of fever, where quinin had failed.

Githagin.—A poisonous principle, obtained by Scharling (Central Blatt, 1850) from the seeds of the *Agrostemma Githago*, or corncockle. It is a starch-like inodorous substance, soluble in water and dilute alcohol, and insoluble in ether.

Atropin.—Rebourdain (Comptes Rendus, 1850) gives the following process for the ready preparation of atropin. Fresh belladonna leaves are to be bruised, the juice extracted by pressure, heated to 176°–194° F. and filtered. When the filtrate has cooled, 4 grm. caustic potassa and 30 grm. chloroform per quart are added, and the whole well shaken together. After an hour's repose, the chloroform, holding in solution the atropin, subsides as the lower stratum, and after decantation of the supernatant liquid, is to be washed repeatedly with water. The chloroform solution is then distilled over a water-bath. The residue in the retort, by digestion with dilute sulphuric acid, yields the atropin. This solution, on treatment with carbonate of potassa, drops the atropin, which may be obtained in acicular crystal by resolution in alcohol and spontaneous evaporation.

Pyrotartaric Acid.—According to Arppe (Liebig's Annalen, lxv.) pyrotartaric acid may be prepared by distilling together, in a capacious green-glass retort, a mixture of equal parts of powdered crystals of tartaric acid and pumice-stone dust. For 2℔ acid, the time required is 12 hours. The distillate is to be mixed with water, the supernatant empyreumatic oil separated by the aid of a funnel, and the liquor gently evaporated and set aside. The crystalline mass which forms is to be pressed between paper, and then spread upon papers saturated with alcohol in order to remove the empyreumatic and coloring matters. The product amounts to 7 per cent. of the acid employed.

Anhydrous Prussic Acid.—Wöhler (Central Blatt, 1850) gives the following process for preparing anhydrous prussic acid. 10 pts. prussiate of potassa, 7 pts. sulphuric acid, and 14 pts. water are mixed together in a retort and distilled over an open charcoal fire. The neck of the retort should be raised to an angle of 45° and occasionally cooled, so as to condense and drive back the aqueous vapor, and thus prevent its passing over into the drying-tube attached, containing the chloride of calcium. Between this latter tube of U shape, there should be another vessel containing a small quantity of chloride of

calcium or cyanide of potassium, and both must be surrounded with water of 86° F. By enclosing the condenser in a mixture of ice and salt, the acid is made to crystallize.

Gallic Acid.—This acid may be made by boiling tannin with dilute sulphuric acid, until the liquid crystallizes on cooling. Wetherill (Journ. Pharm. xii. 107) gives 1 pt. sulphuric acid (1.84) to 4 pts. water, as the proper strength of the acid; and 500 cubic centimetres of this mixture to 50 grm. dry tannin, as the best proportions. The product will be upwards of 40 grm. gallic acid.

Succinic Acid.—Wackenroder has found that much of the commercial acid is adulterated largely with tartaric acid, drenched with oil of amber. (Archiv. d. Pharm. l. 280.)

Chloroform.—Soubeiran (Comptes Rendus, 1847) proposes to prepare pure chloroform for medicinal purposes, by the following process. 10 pts. of the best chloride of lime are mixed with 60 pts. water, well stirred and transferred to a copper still of at least one-third greater capacity than the volume of liquid, adding 2 pts. alcohol of 0.85. The apparatus being luted tightly is heated by a brisk fire. As soon as the mixture reaches 176° a violent intumescence ensues, when the fire must be immediately removed, to prevent the liquid from running over into the receiver. This mishap being guarded against by careful management of the heat, the distillate commences to pass over and continues rapidly. When the action becomes slow, the fire must be restirred in order to hasten it. When the distillate ceases to taste sweet, the process is terminated. The distillate consists of two strata, one dense and yellowish, consisting of chloroform contaminated with alcohol and chlorine; the other is a mixture of water, alcohol, and chloroform, and, after a day, deposits a portion of the latter product. The chloroform is to be decanted, washed by agitation with water, the chlorine removed by a dilute solution of carbonate of soda, and then rectified over chloride of calcium in a water-bath. As the operation is more productive the quicker it is effected, the pulverized chloride of lime should be mixed with hot water.

Soubeiran determines the purity of chloroform by means of a test liquid of 40°, or spec. grav. 1.35, made by mixing equal parts of concentrated sulphuric acid and distilled water, and allowing the whole to cool. One drop of chloroform poured into this liquid will sink if it is free from alcohol.

Böttcher's process (Polytech. Notizbl. No. i.) is to distil to dryness, in an iron retort, equal parts of acetate of soda and chloride of lime. A large quantity of dilute acetone and but little chloroform passes over. The distillate is then to be mixed with chloride of lime and again distilled, and the same process repeated a third time, in order to decompose the whole of the acetone. The last distillate is to be rectified over caustic lime.

According to Soubeiran and Mialhe (Journ. de Pharm. 1849) there are two kinds of chloroform in commerce. One, the *normal* chloroform, prepared by the action of hypochlorite of lime upon alcohol; the other made from pyroxylic spirit instead of alcohol. The latter (*methylic chloroform*), though similar in appearance to the former, is less sweet, has a different odor, and produces nausea. Its spec. grav. is only 1.413, and its boiling point much lower than true chloroform. These discrepancies do not proceed from any actual difference in the two liquids, but are owing to the presence of a peculiar chlorinated oil, obtained in both instances, but readily separable from the normal chloroform. It is to the presence of this oil that the nausea and other ill effects of chloroform in certain instances are attributable, and therefore methylic chloroform is unfit for inhalation, it being impossible to remove all the empyreuma from it. To separate it from normal chloroform, the latter must be distilled, and the process stopped before the end of the operation, in order to prevent the reproduction of the mixture.

When chloroform is poured upon a doubled sheet of bibulous paper, one portion soaks through, and another, by its rapid evaporation, produces sufficient cold to congeal it into crystals.

Alcohol in Chloroform.—Cattel detects the presence of al-

cohol in chloroform by adding one or two crystals of chromic acid to 2 drachms of the suspected mixture. If it contains alcohol, the acid is soon reduced to green oxide. (Journ. de Chim. Méd. iv. 257.)

On the tests and purification of chloroform, by Dr. Gregory, see Chem. Gaz. viii. 189. The method was afterwards shown to be defective, rendering the chloroform liable to decomposition.

Collodion.—Maynard (Silliman's Journ.) was the first to propose an ethereal solution of gun-cotton as a substitute for adhesive plaster. The ordinary gun-cotton is, however, somewhat insoluble in ether. It must therefore be prepared by a special method, known as Malgaigne's (Lond. Med. Gaz. 1848), which gives a perfectly soluble product.

Mix together, in a stone pan, 40 oz. purified nitre in powder, with 60 oz. of sulphuric acid of 66°, and stir in 2 oz. of finely-carded cotton. After 3 minutes, remove the cotton with a glass rod and plunge it into a large volume of water, and renew the washing with fresh water until the removal of all acidity. Press, dry in a warm room, and pull out the wool. 8 oz. of this cotton form, with 125 pts. of rectified ether, a ready solution, which must be diluted with 8 pts. of rectified alcohol and strained through a linen cloth.

The liquid is the collodion of the shops, now much used for surgical purposes. It is applied either alone with a brush, or upon a linen cloth. Its adhesiveness is said to be increased by the addition of Venice turpentine. The parts to which it is to be applied must be free from all dampness, as water decomposes the collodion.

When containing one grain of morphin to the ounce, it is also a very efficient remedy for the toothache.

As the solvent of ethereal extract of cantharides, it is an admirable blistering-plaster. It may be spread on with a camel's hair pencil. The evaporation of the ether leaves a dry coating in a few seconds; and as soon as the principle of the cantharides begins to act upon the epidermis, the coating rises and forms a blister. If opened at the side, the film

of collodion remains unbroken, and by thus protecting the sore obviates the necessity of dressing it with ointment. It is a much more active, cleanly, and convenient vesicant than the *unguent. cantharid.* (Lond. Pharm. Journ. 1850.)

Benzole.—This liquid carbohydrogen, so valuable as an economical solvent of caoutchouc, gutta-percha, resins, and other difficultly soluble substances, is readily prepared by Mansfield's process (Journ. of Chem. Soc. i., and Chem. Gaz. vii.) from coal-tar.

The light coal-naphtha, obtained in the early stage of the distillation of coal-tar, is distilled in a metal retort having its head surmounted with a chamber containing cold water, so that the liquids less volatile than water may be condensed and fall back into the retort or into a separate receiver, while those more ethereal pass on in vapor to a condensing vessel kept cool with water or ice. The liquid ceases to pass as soon as the water in the chamber commences to boil, because all vapor volatile below 212° has then been driven over into the condenser. The distillate is rectified by a second distillation as above, taking care, this time, that the temperature of the water surrounding the head of the still shall not quite reach 176° F., that being the boiling point of Benzole. The distillate obtained before the temperature within the retort has risen to 194° F., is a yellowish volatile oil, which at 4° F. drops one-half of its bulk in crystals.

This liquor, by agitation with one-tenth its volume of strong nitric acid for the removal of the oxidable substances, and, subsequently, after separation from the acid, with one-fourth its volume of oil of vitriol, to separate neutral oils, basic, and coloring matters, is prepared for the last distillation. All the distillate obtained below 194° is to be reserved and washed with water, and finally with an alkaline solution. The purification is completed by congealing it at 4° F. and pressing out the solid portion, filtering, and drying by means of chloride of calcium.

The volatility of benzole imparts great value to it as the solvent of resins for forming varnishes, or artificial cuticles in

dressing wounds and burns. Those resins, as copal, &c., which do not dissolve in the liquid, yield readily to the vapor.

Air or coal-gas, surcharged with benzole, yields a flame of highly luminous power, and the author has recommended (Ch. Gaz. vii. 188) a system of illumination based upon this property.

So also, when mixed in the proportion of one volume to two of alcohol or pyroxylic spirit of .840, it forms an admirable burning fluid.

It, moreover, possesses anæsthetic properties.

V. KALISTICS.

It embraces the ornamenting and modifying of tissues, such as yarns, cloths, horn, ivory, paper, leather, &c., and may accordingly be divided into processes performed on *textile fabrics*, yarn, cloth, and on *sheet fabrics*, paper, leather, gum-elastic; while a third division embraces the cements and varnishes employed upon those fabrics.

1. Textile Fabrics

Includes the preparation of fibre and dyes, the processes of dyeing and calico-printing.

1. *Fibrous substances*, such as cotton, wool, silk, &c. are bleached and dyed of various colors, either in the crude state, or as yarn, or woven into cloth. When colored uniformly, throughout, they are said to be dyed; when colored topically, or according to figures and designs, they are said to be printed. The term calico-printing has been applied to topical dyeing, but the general term should be *color-printing*, since the art consists in the application of colors to textile fabrics of cotton, wool, silk, &c., as well as to wall-paper.

Flax and Hemp Retting.—The process of retting, as usually practised, is objectionable on many accounts; it requires much time, the putrefaction disseminates a disagreeable, and, it is believed, a miasmatic odor; and it is moreover very liable to be carried too far, to the injury of the fibre. Poole's method (Rep. Pat. Inv. 1845) consists in the use of dilute acid to dissolve the material which glues the fibres together. A bundle of flax or hemp is saturated with water and exposed to the air for 8–9 hours, then again saturated towards evening and exposed for the night. The following morning it is put into a vat containing sulphuric acid diluted with 200 pts. water for hemp

(with 400 pts. for flax), and, after a time, is removed and put on a lattice. The operation is repeated in the course of 5–6 hours, and oftener, until the retting is complete, which is indicated by black spots on the stems. It is then rinsed thoroughly in water, passed through a bath of 1 pt. potash in 10,000 pts. water, to neutralize any remaining acid, and, lastly, rinsed in clean water, and dried.

Hemp and Linen, with New-Zealand Flax.—New-Zealand flax diminishes the value of cordage, &c. made of hemp or flax, rendering it less durable. Vincent gives the following method of detecting the mixture. (Comptes Rendus, 1847.) Hemp fibre, dipped for a few seconds into nitric acid, is colored pale-yellow, linen not at all, and New-Zealand flax blood-red. A piece of cloth, containing both flax and New-Zealand flax, dipped into the acid, showed red striæ in the woof and none in the chain, which was all common flax.

To detect Cotton in Linen.—Elsner has published a critical review of the various methods proposed to distinguish cotton and flaxen fibres (Berlin. Industrie u. Handelsbl. xxiv.), the best of which we extract from his report. Stöckhardt observed that a flaxen fibre, inflamed in a vertical position, and then extinguished, appeared to be carbonized at that end in a smooth, coherent shape, while cotton, similarly treated, appeared to be spread out like a brush or tuft. Elsner observes that it especially occurs when the flame is violently blown out, and that it succeeds with dyed goods, unless dyed by chrome yellow.

The potash test consists in putting the fibre into boiling caustic potassa-lye for a couple of minutes, when the flax turns deep-yellow and the cotton is scarcely changed. The test is not reliable.

One of the best is the microscopic examination, for when flax is magnified 300 times, it appears like long, compact tubes, with a narrow channel in the centre, while cotton appears to be flattened, ribbon-like cylinders, with a wide channel, and mostly in spiral windings.

The test with oil of vitriol is reliable in an experienced

hand, but every trace of weaver's gum must have been previously removed by boiling with water. The fibres are laid on a plate of glass, and oil of vitriol dropped on it. A single lens is sufficient to observe the effect. In a short time the cotton fibre is dissolved, the flax unaltered, or only the finest fibres attacked.

The oil test is also a good one, and convenient in execution. When flaxen fibres are rubbed up with olive-oil, they appear transparent, like oiled paper, while cotton, under similar circumstances, remains white and opake. Dyed goods exhibit the same, if previously bleached by chloride of lime.

Elsner's method consists in putting the fibres for a few minutes into a tincture of various red dyes, of which cochineal and madder give the most striking results. The tincture is made by putting 1 pt. madder, &c. into 20 pts. common alcohol for 24 hours. In the cochineal tincture, cotton is colored bright-red; flax, violet;—in madder, cotton becomes light-yellow; pure flax, yellowish-red.

It is better to employ several of these tests, the microscopic, oil, sulphuric acid, and combustion, rather than to rely upon a single test.

Tanning Cotton and Linen.—English and French fishermen have been long in the habit of tanning their sails, &c. in bark liquors, in order to render them more durable. Millet states that pieces of linen, treated for 72 hours with an oak-bark liquor at 150°, and stretched on frames, remained unaltered in a damp cellar for 10 years; while untanned linen in the same place and for the same time had entirely rotted. The one frame, also tanned, was perfectly preserved, and the other, untanned, had rotted. It was further shown that linen, which had begun to moulder, might be preserved from further change by being tanned. It seems to be only necessary that the articles should be kept 2 or 3 days in a warm solution of tannin. Sponge may be similarly tanned.

2. *Bleaching.*—The oldest process of employing sun and dew is still resorted to, but has been almost supplanted by the use of chlorine or chloride of lime. The new and singular

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substance, ozone (singular, because but little understood), seems to possess bleaching properties, and hence we notice it.

Ozone.—Phosphorus kept in moist air imparts to it the property of bleaching various vegetable colors, and when kept too long in this air, their texture is weakened, as in bleaching by chlorine. Such air is termed ozonized air by Schönbein, who first investigated its properties, and called the substance itself ozone. A convenient way of making ozonized air is to cover the bottom of a capacious bottle with water, to set in it a stick of phosphorus, which must rise above the water, to close it loosely with a cork, and place it in a temperature of 60–68°. The air will be ozonized in the course of an hour, may be used, and fresh ozone obtained with the same arrangement.

Its bleaching effects are due to its large content and loose combination of oxygen, analogous to that of binoxide of hydrogen, and to that of dilute solutions of chlorine. A coloring substance is changed in its nature by oxidation, and new colorless compounds formed. Schönbein has further shown its oxidizing effect on protosalts of manganese. By writing with a solution of sulphate of manganese, and putting the dry writing for a short time into a bottle of ozonized air, the writing appears of a brown color, from the formation of peroxide of manganese. The writing will vanish in sulphurous acid by reduction to protoxide, and will reappear in ozonized air.

Bleaching Sponge.—After extracting lime by dilute muriatic acid, and washing with water, it is put into very dilute muriatic acid and a solution of chloride of lime added, after which it is rinsed in water and passed through an acid bath. It is then put into very dilute sulphuric acid, containing sulphite of soda, thoroughly washed, pressed out and dried. (Kressler in Journ. f. Chem. u. Pharm. lxiv.)

Bastick, examining the effect of chloride of lime upon starch, sugar, cotton, &c., found that when free lime is present, formiate of lime is produced; when absent, carbonic acid is generated. (Journ. Pharm. (3) xiv.) It appears then that

where the alkaline base is absent, the decomposition by oxidation is more violent: a fact of importance in the use of this bleaching agent.

Bristles Bleached.—Winkler and Fink give the following as the best method of bleaching bristles. (Monatsbl. d. Hessisch. Gewerbver. 1847.) They are first well washed in a solution of soft-soap in luke-warm water, rinsed in cold water, then laid for 2–3 days in a saturated solution of sulphurous acid in water, well washed, and dried. By merely moistening and exposing them to the air, most kinds may be bleached, and still better by moistening them with very dilute sulphuric acid, and sunning them. In the latter case, however, Winkler observed that they were slightly attacked by the acid.

3. *Mordants.*—Under *Chemics*, we have seen the preparation of the two great mordants, alum and copperas, together with several others. A few are prepared more exclusively for the dyer, and some by the dyer himself.

Persulphate of Iron.—A mixture of powdered copperas and some soda-saltpeter is ignited for a short time in a crucible, and, when cooled, extracted by water. The presence of the sulphate of soda, also formed by the process, does not interfere with its employment in dyeing, &c. Elsner properly remarks that this process is not as economical as the older method of heating a due mixture of oxide of iron and oil of vitriol in a cast-iron vessel. It may nevertheless be sometimes convenient to employ it. (Mechan. Mag. 1847.)

A good article on the nitrates of iron, &c., appears in the American Journal, 2d series, ix. 30, by Ordway.

Nitrate of Copper.—This salt may be made by mixing 1½ pts. powdered blue vitriol with 1 pt. soda-saltpeter, moistening it with water, and heating it in a crucible until the fluid mass begins to evolve red vapors. The solution then made will contain sulphate of soda, which does not injure its value to the dyer. (Mechan. Mag. 1847.)

Tin-salt.—C. Nöllner proposes (Ann. der Chem. u. Pharm. lxiii. 120) to adapt stoneware receivers to the retorts in which muriatic acid is generated, and to fill them with granulated

tin. The concentrated solution of tin thus obtained is evaporated in a tin pan, containing an excess of granulated tin; so that the pan will not be acted on, because it becomes positively, and the granulated tin negatively, electric. All copper present in the solution is precipitated as a black powder on the granulated tin.

Salts of Tin.—Bouquet, in his paper upon the preparation of some protosalts of tin (Journ. de Pharm. xi. 460), gives the following formula for making the sulphate of the protoxide (SnO,SO_3). Dissolve recently precipitated protoxide of tin in warm dilute sulphuric acid. Nacreous plates of sulphate separate on cooling.

Stannate of Soda.—It is usually made by adding caustic soda-lye to a solution of chloride of tin. Another method, suitable for dyeing and color-printing, consists in heating 22℔ caustic soda in an iron crucible to a red-heat, adding 8℔ soda saltpeter and 4℔ common salt, bringing it to fusion, and then adding 10℔ granulated tin. The heat is continued until ignition takes place and the mass has a doughy consistence. It may be powdered and used at once, or may be purified by solution in water and crystallization. (Journ. of Arts, 1846.)

Arseniate and Stannate of Soda.—Stannate of soda is made as usual from oxide of tin and soda, or tin and nitrate of soda, and dissolved in water until it reaches 50° Twaddle, and about 1½℔ arseniate of soda (made by fusing together equal parts of arsenious acid and nitrate of soda) is added to a gallon of the hot solution, in an iron vessel over the fire. As soon as a little of the mass taken out congeals at once, the compound is completed. In like manner, phosphate of soda may be added to the stannate, in order to make phosphate and stannate of soda. (Lond. Journ. Aug. 1850.)

Lead Mordants.—The best mordants of lead are: 1. Basic acetate of lead, obtained by digesting litharge in a solution of sugar of lead; 2. Potassa-lime and oxide of lead, obtained by digesting litharge in a solution of caustic potassa containing lime; and, 3. A similar solution with soda instead of potassa. All these mordants give a beautiful chrome-yellow. A

gray is obtained by passing the goods thus mordanted through a solution of sulphuret of calcium; and a deep-black by the same, finishing with iron mordant and campeachy wood. (Technologiste, 1846.)

New Mordant.—Broquette's new method of fixing colors, or his new mordant, is a solution of casein in ammonia, with which the goods are impregnated, and then heated to expel the ammonia and leave the casein on the cloth. He has also employed casein with lime alone, or with lime and ammonia. See Chem. Gaz. viii. 384.

4. *Dye-stuffs.*—Many experiments have been recently made on well-known dye-stuffs, especially on the invaluable madder, and a few new dyes have been added to the list; but experience alone can prove their durability, beauty, and economy.

Madder.—The investigation of this valuable coloring-substance is attended with many difficulties, in consequence of the presence of several different coloring principles, which have some analogy in color, are different in their properties, and yet, according to some observations, one may be transformed into another. It is probable that the substances *alizarin* and *xanthin*, found some twenty-five years since, were not pure. In 1835, Runge described, in a valuable essay on madder, five coloring principles in it, *madder-purple*, *red*, *orange*, *yellow*, and *brown*, and mentioned also two acids, *rubiacic* and *maddric;* but he viewed the sesubstances solely as a dyer and not as a chemist, leaving the most important part undone, their more important combinations, transformations, and their composition.

Schiel also examined the colors of madder. (See essay in Ann. d. Chem. u. Pharm. Oct. 1846.) To prepare *madder-purple*, water is poured over the ground madder in a wooden vat, suffered to stand for 1 or 2 days, and drawn off. The madder is then pressed, boiled in a copper vessel with a strong solution of alum, and filtered hot. It deposits a reddish-brown substance, which is separated by filtration. Sulphuric acid is added to the red solution, which deposits the purple in 24 hours. The latter is again dissolved in alum and precipitated.

It is then boiled with muriatic acid, washed with cold water, dissolved in alcohol, and the solution evaporated, when it deposits the pigment. It is, lastly, dissolved in ether several times, and separates from it by evaporation. It is a cherry-red powder, insoluble in cold water, rather soluble in hot, very soluble in alcohol and ether; soluble in alkalies with deep-red color, and reprecipitable by acids. It fuses by heat, and sublimes with partial decomposition, condensing in the form of red needles, which dissolve in alkalies with a violet color. Its composition is expressed in the formula $C_{28}H_{10}O_{15}$. Both madder-purple and madder-red dissolve in cold oil of vitriol, with a brilliant red color, and are again precipitated unchanged by the addition of $\frac{1}{3}$ its volume of water. Hence, in preparing *garancine*, the oil of vitriol should be diluted with $\frac{1}{3}$ its volume of water, which would not dissolve the colors, while it chars the woody fibre.

Madder-red is contained in the precipitate which separates from a cooling decoction of madder. After repeated purification, it is a yellow powder, difficultly soluble in water, readily soluble in alcohol and ether, soluble in potassa with a violet, in ammonia with a red color, sublimes at 437°, and deposits orange-yellow needles. Both the sublimed and the unsublimed appear to have the same composition, expressed by the formula $C_{28}H_9O_9$. The red appears to pass into the purple by taking up 1 eq. water and 5 eq. oxygen. $C_{28}H_9O_9+HO+O_5=C_{28}H_{10}O_{15}$.

Schunck performed a series of experiments on madder root, from the aqueous extract of which he obtained alizarin, *rubiacin*, α and β resins, a bitter principle *rubian*, *pectic* and *rubiacic* acids, and a dark-brown substance. After thorough extraction by water, and then by hydrochloric acid, which removed lime and magnesia, he obtained by extraction with potassa, alizarin, pectic acid, β resin, and probably rubiacic acid. Alizarin has the formula $C_{14}H_5O_4+3HO$, soluble in pure water with a yellow color, in alcohol and ether; soluble in caustic and carbonated alkalies, with a brilliant purple color; the potassa solution is precipitable by alumina, which becomes reddish-purple; by

peroxide of iron, which becomes blackish-purple. It is soluble in sulphuric acid, and reprecipitable by water unaltered; hence its permanency when madder is charred by oil of vitriol. Nitric acid, pernitrate and perchloride of iron convert it into alizaric acid. Rubiacin (probably Runge's madder-orange) has the formula $C_{31}H_9O_{10}$, is slightly soluble in boiling water and in sulphuric acid without decomposition; in caustic potassa with a purple, and in carbonated with a blood-red color; forms a dingy-red precipitate with chloride of calcium, and an orange-colored compound with alumina, which last is soluble in potassa with a purple color. Boiling pernitrate or chloride of iron changes it to *rubiacic acid.* The resins are slightly soluble in boiling water; the α resin in caustic and carbonated alkalies with a purple-red color, β resin with a dingy-red color. Rubian is the bitter, nitrogenous principle. Schunck believes alizarin to be the active dyeing substance in madder, although he states in one place that rubiacin assists in brightening color when alkali is present. He thinks that the resins impart a yellowish, and xanthin a brown tone to the color. (Ann. Ch. Pharm. lxvi. 174.)

Higgin ascribes some effect to rubiacin and xanthin in dyeing. He believes that xanthin passes by a kind of fermentation, first into rubiacin and then into alizarin, and that the resins are products of decomposition with boiling water. (Phil. Mag. (3) xxxiii. 282.)

Residue of Madder.—Wydler proposes the following method of using the residue of madder, exhausted by dyeing (Schweizer Gewerbebl. 1847). The pressed residue is mixed with 40 per cent. oil of vitriol, the mixture steamed for an hour, and then washed until the wash-water tests no longer acid. It is said to yield as much color as before.

Madder-lake.—A fine madder-lake is thus prepared from an ordinary article, by Kressler. 1 oz. common madder-lake is powdered, treated with 2 oz. strong acetic acid (1.045), stirred frequently, set aside for 12 hours, then diluted with 6–8 pts. distilled water, and filtered. Twice as much boiling water is added to the clear filtrate, and then gradually a dilute

solution of carbonate of soda (3–4 oz.) until all is precipitated. The precipitate is filtered, washed, pressed in linen, and dried in the shade. It has a rich carmine color, and rubbed on glass with a good oil-varnish, appears as transparent as red glass. Its solution in strong acetic acid gives a beautiful and durable red ink, which does not mould and requires no gum. It may be diluted at pleasure.

For the properties of a new dye of somewhat analogous character to madder, we refer to the Lond. Journ. xxxvi. 335.

Red Coloring-matter of Rhubarb.—The *erythrose* of Garot (Journ. de Pharm. et de Chim. 1850) is extracted from rhubarb by acting on 1 pt. with 4 pts. of nitric acid. The residue, remaining untouched, is the coloring-matter, and varies in different rhubarbs from 8 to 20 per cent. It is orange-red, soluble in alcohol and ether, and forms with the alkalies red compounds of eminent tinctorial power. It is said to give a dye of much greater brilliancy and stability than that from cochineal.

Cochineal.—Warren de la Rue (Chem. Soc. Trans. 1847) thus obtains the coloring-matter. 3℔ powdered cochineal are boiled for 20 minutes in 60 litres distilled water, strained, and poured off clear in ½ an hour. It is then precipitated by a solution of acetate of lead previously acidulated by acetic acid (6 pts. acetate, 1 pt. acid), the precipitate washed with boiling water, dried in warm air, and powdered. This yields 17 oz. crude carmine-oxide of lead. The cake is suspended in water, sulphuretted hydrogen passed through, the deep-red solution evaporated in a water-bath, and lastly dried in vacuo.

The crude carminic acid contains phosphoric acid, and to purify it, it is dissolved in boiling absolute alcohol, and digested for some hours with carminate of lead. Ether is added to the solution, which precipitates a little nitrogenous matter, and the filtrate evaporated in a retort, and finally dried in vacuo. It is the pure cochineal-red or carminic acid.

This substance is a purplish-brown pulverizable mass, transparent under the microscope, of a beautiful red color when finely divided, decomposed by chlorine, bromine, iodine,

and nitric acid, above 277°. It is soluble in all proportions in alcohol and water; difficultly so in ether, its solution giving an acid reaction. The alkaline earths throw it down of a purplish color; the acetates of lead, copper, zinc, and silver, purplish-red. Sulphate of alumina does not throw it down, but upon adding a little ammonia, a brilliant carmine-lake is precipitated. The chlorides of tin do not precipitate it, but impart a rich carmine tint to the liquid. Its formula is $C_{28}H_{14}O_{16}$.

Alkanet.—Bolley gives (Schweizer Gewerbebl. 1847) a method of preserving the tincture of alkanet, which is valuable, since alkanet is a costly dye, and its tincture produces a peculiar violet of the fastest character. The method consists simply in the addition of a very little pure muriatic acid to the tincture, a few drops being sufficient for large quantities. Its action is supposed to be its neutralizing a little ammonia, which is the cause of the tincture spoiling; but it is more probable that it combines with the substance from which the ammonia is produced by decomposition.

Rocella Tinctoria (*Orchil, Cudbear*).—Schunck's examination of this lichen is described in Ann. d. Chem. u. Pharm. lxi. 64, &c. The cut lichen is boiled in water for some time, in a spacious vessel, and the yellowish-brown liquid strained. On cooling, white flocks and crystals separate, and when filtered off, washed and dried, are gray. Dissolved in boiling alcohol, a slight-brownish residue remains, and the cooling solution deposits a white crystalline substance, Heeren's erythrin, Kane's erythrilin, and Schunck's erythric acid. It is the most important constituent of the lichen, as it produces the color for which the lichen is gathered. 1℔ lichen yields about 50 grains.

It is white, tasteless, soluble in alcohol and ether; 1 pt. dissolves in 240 pts. boiling water, but the greater part separates on cooling; it is also more soluble in boiling than in cold alcohol; its solution reddens litmus; it is soluble in caustic and carbonated alkalies, in lime and barytic water, and is again precipitated by acids in a gelatinous form. Its

tincture is not precipitated by a tincture of acetate of lead, but a solution of subacetate gives a large precipitate. Its solution in ammonia, by exposure to the air, becomes purplish-red. By continued boiling in water it is converted into picroerythrin. Heated on platinum foil, it fuses and burns without residue; heated in a glass tube, it yields first an oily, then a crystalline sublimate of orcin. Erythric acid is the basis, and, according to Schunck, the only basis of all the coloring-matters of the lichens. Its composition is $C_{34}H_{19}O_{15}$.

Picroerythrin is a product of the decomposition of erythric acid, and is the cause of the bitter taste of an extract of lichens. A hot solution of the acid, evaporated, leaves a brown glutinous mass, which becomes solid and crystalline, has a bitter taste, and leaves white picroerythrin when extracted by cold water. Its composition is $C_{34}H_{24}O_{20}$; and it is formed from the acid by its taking up the elements of 5 eq. water.

Extraction of Color from Orchil.—Chandois (Ch. Gaz. vii.) exhausts the lichens by repeated washings with water, and separates the coloring-matter from this liquid by means of ammonia or alkali.

New Mode of Testing Indigo.—Reinsch's new process (Jahrbuch für Pract. Pharm.) for testing the coloring power of indigo is said to give accurate results, with greater facility than the usual methods. It consists in the use of a standard solution, made by triturating 1½ gr. finely-powdered Bengal indigo, of best quality, with 4 or 5 drops of very concentrated fuming sulphuric acid, and when the mass has become uniformly brown, adding 15 gr. more of the same acid. The rubbing is to be continued until the mixture turns green, when another 15 gr. of acid is added, and the whole diluted with 150 gr. water. Two uniform cylinders having been previously graduated into 20 equal divisions, one is to receive 15 gr. of the above solution, or more if necessary, to give a light-blue liquid by filling the glass with water. The other cylinder is similarly filled, to determine whether the contents of the two are alike in shade. This being so, one is emptied, and then,

having received 15 gr. of solution of inferior indigo, prepared as above directed, water is to be poured in until it assumes the tint of the standard liquor. The difference in the quantity of water required to produce a uniformity of shade in the two liquids, denotes the ratio of the quality of the indigoes employed. For example, 20 pts. water were used for the standard solution, whereas the same quantity of the indigo under test required only 15 measures to produce the same degree of coloration: therefore the latter contains 25 per cent. ($\frac{5}{20}$ths) less of coloring matter than the former.

The author gives the following results of certain essays with solution of best Bengal indigo, = 20.

Bengal, No. 2, quality	19
" No. 3, "	7
Java, No. 1, quality	19½
" No. 2, "	18½

Coloring-matter of Soorangee.—This material, extensively used by the native Indians as a dye, is imported from Bombay. According to Dr. Anderson, it is the root of the *morinda citrifolia.* His examinations (Ch. Gaz. vi.) prove that it contains a red coloring principle *morindin*, extracted by alcohol, which is very similar to madder-purple both in physical and chemical properties and in composition, though differing remarkably as a dye. Its behavior to mordants is given in detail in the original paper.

Wongshy.—This new yellow dye, imported from Batavia, according to Stein (Journ. f. Prac. Chem. 1849), consists of the seed-vessels of a plant of the family of gentianæ; by trituration with water it gives a reddish-yellow liquid which retains its color even when largely diluted. Alcohol acquires by digestion with it a bright-red tint. It yields an orange-color to unmordanted woollen cloth; cottons require to be mordanted. The color resists the action of soap, but is yellowed by alkalies and reddened by acids, and fades by exposure to light. The details of the author's experiments are given in the original paper.

See a full essay on this material in the Lond. Journ. xxxvi. 265–273.

5. *Dyeing.*—Some goods will receive a color directly from a solution and retain it, but in most cases it is necessary to impregnate the goods first with a mordant or color-base, and then to pass them through the dye, which adheres to the color-base. We present a few suggestions which have been recently made in reference to dyeing.

In place of the cream of tartar used in woollen fabrics, a patentee (Lond. Journ. xxxvi. 385) proposes mixtures of salts and acids, enumerating 8 acids, 4 alkaline chlorides, 3 alkaline sulphates, besides alkaline acetates, nitrates, oxalate, borate, and sulphate of zinc. Out of these twenty salts and their scores of compounds, one may possibly succeed.

Recovery of Soap from Scouring—Where large quantities of soap are used, as in scouring wool, cotton, &c., it may be recovered by adding muriate of lime to the wash-water (which is a solution of soap), and precipitating the salt of lime with the fat acids. The salt, being collected, is easily decomposed by sulphuric or muriatic acid, and the fat acids obtained to be again used in the making of soap. This is the subject of an English patent. See Rep. Pat. Inv. July, 1850.

Orchil, Cudbear.—Lightfoot proposes (Lond. Journ. Sept. 1850) preparing vegetable textile fabrics by the Turkey-red preparation (pearlash, olive-oil, and water) by 10–12 paddings, then padding in acetate of alumina or aluminate of potassa, and dyeing in orchil or cudbear. He also proposes impregnating the goods with salts of magnesia, lead, zinc, copper, tin, &c., and fixing the base by alkali before printing with orchil or cudbear. The proposition to use cobalt or nickel salts is absurd on account of their cost.

Indigo.—According to Chevreul (Comptes Rendus, 1846) indigo is more permanently fixed on woollen goods, dyed in the hot vat, by steaming them, or by a boiling bath of alum and argal, or tin-salt and argal, or by a bran-bath, or, lastly, by a solution of potassa or soda.

Red Prussiate of Potash.—Dr. Meitzendorff published an

essay in the Verhandl. z. Beförd. d. Gewerbfl. in Preussen, 1846, on the process of shading with blue on woollen-yarn.

Chromate of Lead, as a Gold-yellow for Cotton.—The gold-yellow color with a silky lustre, on cotton-yarn, is prepared by mordanting in a solution of subacetate of lead, and then passing it through bichromate of potassa, acidulated with nitric acid; after thoroughly rinsing in water, it is dipped for a few minutes into an alcoholic tincture of saffron, and dried in the shade without previous washing. (Innerösterr. Industr. und Gewerbebl. 1847.)

Chrome Dyes.—Kurrer (Ch. Gaz. viii. 461, and Lond. Journ. Aug. 1850) has made some valuable contributions to the chemistry of colors, in an essay on chrome dyes. As these latter resist the action of light, acids, and alkalies, they may be considered fast colors. The new methods of preparing the different shades, with the requisite proportions of materials to be employed, are given in the original paper, which may be profitably consulted.

Sea-green.—Prepared by dissolving hydrated peroxide of chrome in dilute hydrochloric acid, carefully neutralizing excess of acid with caustic potassa, and evaporating solution to 46° B. The chrome oxide is precipitated from solution of bichromate of potassa by arsenious acid.

For cylinder-printing, either starch or gum tragacanth may be used for thickening; but the gum is preferable, because it gives colors of greater depth and richer tone.

The prints are brightened, after being stretched over night in a cool place, by passing them through caustic potash-lye of 2° B., airing, pressing, washing, drying, and, finally, by immersion in a bath of acetate of copper, rinsing, and drying.

Olive.—The addition of catechu-brown to the chloride of chrome, in varying proportions, produces the different shades of olive.

Pearl-gray.—This tint is obtained by a mixture of sulphate of chrome and chrome alum. The prints are finished by immersion in milk of lime, rinsing in hot and cold water, and drying.

Black Dye for Felt Hats.—The composition of this dye, for which a prize was awarded, is as follows. 1. The felt hat-bodies are first cleaned, and galled by passing them through the following solution, and washing: fustic, copperas, argal, each 8lb, are boiled together in water for half an hour. 2. The dye-bath consists of 55lb campeachy wood, 1½lb gum, 3lb galls, which are boiled together in water for 3 hours. To produce the black color, 5lb refined verdigris, 2lb each of blue vitriol, sugar, and quicklime, are added to the bath. (Bulletin de la Société d'Encouragement, August, 1846.)

6. *Color-printing.*—The expansion of chemical science and of calico-printing are simultaneous, and must necessarily be so, for this beautiful art includes in it a larger share of the principles and practice of chemistry than any other, or perhaps than all other arts. Little of the experience of the calico-printer is published, except by the issue of his beautifully finished goods, and the cost of that experience is a sufficient apology for his silence.

Steam-blue for Printed Goods.—According to Petersen (Polytech. Centralbl. 1847, 14) a topical blue for cotton, silk, wool, &c. is obtained by printing a thickened mixture of prussiate of potash with tartaric or sulphuric acid, and steaming. The ferrocyanhydric acid, thus set free, penetrates the fibre, depositing cyanide of iron, somewhat colored, which first assumes a fine color by oxidation in a bath of chromate of potash or chlorine, a blue protopercyanide being formed.

The lively tone of French blue is due to the use of tin-salt together with the others, or to ferrocyanide of tin, which is obtained by adding tin-salt to prussiate of potash.

Prussian-blue for Calicoes.—A solution of pertartrate and persulphate of iron is treated with ammonia in excess, and then with yellow prussiate of potash. Cotton is not immediately colored when dipped into this solution, but by subsequent exposure to the air, it assumes a violet-blue, which passes into a beautiful deep-blue when passed through a bath of tin-salt. (Dingl. Journn. xcix. 399.)

White Discharge on Indigo.—This is usually effected by

bichromate of potassa and an acid, but is objectionable because the white ground requires cleaning. Mercer (Phil. Mag.) proposes to effect it by red prussiate of potash and caustic alkali; for when the former is printed on, and the cloth is then passed through dilute caustic-lye, a brilliant white is discharged.

Ammonia-oxide of Copper.—Runge draws attention to the resolution of sulphate of copper in ammonia (Polytech. Notizbl. 1847), and shows its utility for color-printing, when mixed with decoctions of plants. Thus, catechu gives almost the same brown as chromate of potassa, by fusing 1 pt. catechu in 4 pts. water, adding 12 pts. of the liquid ammonia-oxide of copper, and printing with the liquid, thickened with tragacanth. It shows a singular action on the yellow color which separates from a cold infusion of French berries. This color, when treated with the ammoniacal copper, becomes reddish-brown in the course of 6–8 hours, and if then treated with alcohol, the brown copper-salt is left, and a red color dissolved, which yields compounds with alumina of a beautiful red, like those from madder.

Pyrophosphate of Copper and Potassa.—Persoz proposes this double salt for calico-printing, as it is decomposed by zinc or iron with less facility than any other salt of copper, and as difficulties attend the use of other salts of copper. (Ann. de Chim. et de Phys. and Journ. f. Prac. Chem. xli. 361.)

7. *Coloring Fluids.*—We may conveniently embrace under this head various fluid inks, which are liquid dyes; as well printing-inks, which are pasty dyes, printed on from a type or pattern.

Black Ink from Logwood.—Boil 125 pts. rasped logwood with so much water that it will yield 1000 pts. of the decoction, and when cold, stir in 1 pt. yellow chromate of potassa. It is a beautiful blue-black, and gives no precipitate. But if too much chromate be used, or the decoction be too concentrated, a dark precipitate takes place. (Runge's Grundriss d. Chem. ii. 207, 1847.) Being free from acid, it will not corrode steel pens, but it does not write as freely as our most fluid inks, made from nut-galls and copperas.

Another ink is made by adding a very small quantity of blue vitriol to a solution of logwood-extract. This is apt to precipitate.

Soluble Prussian-blue (a Blue and Black Indelible Ink).—Dissolve in a solution of iodide of potassium as much more iodine as it contains, and pour this solution into one of yellow prussiate of potash, containing as much of the solid prussiate as the whole amount of iodine. Soluble Prussian-blue precipitates and iodide of potassium remains in solution. After filtering, the precipitate is dissolved in water, and forms a blue ink, containing no free acid, and therefore adapted to steel-pens. If the soluble blue be added to common black ink (from galls), the result is a black ink which cannot be removed from paper without destroying it.

Indelible Ink.—To remove spots of indelible ink, T. and H. Smith propose moistening the spots for a few moments with moist chloride of lime, which forms chloride of silver, and then dissolving the latter by caustic ammonia. It may be sometimes necessary to repeat the operation. (Chem. Gaz. Sept. 1847.) Cyanide of potassium may also be employed.

Printing-ink.—Pratt's patent consists in the use of rosin-oil, instead of linseed oil, with rosin, yellow soap, &c., in the manufacture of printing-ink.

2. Sheet Fabrics and Solid Tissues.

Among these are paper, leather, horn, caoutchouc, &c., of which caoutchouc and guttapercha, being new, and presenting remarkable properties, have been most rapidly advanced of all others, during the past few years.

Paper.—Amos and Clark claim improvements in the manufacture of paper, whereby, 1. The bluing material is more uniformly distributed so as to equalize the tint on both sides of the paper; 2. The pulp is more expeditiously sifted; 3. The paper is better dried on the cylinders; 4. The paper is glazed by means of a traversing horizontal table with two or more pairs of rollers. (Lond. Journ. xxxvii. Aug.)

Bleaching Paper.—After bleaching the pulp by chloride of lime, small quantities of this salt or chlorine remain in the paper, tending to injure its quality. It is entirely removed by sulphite of soda, which is converted by chlorine and water into muriate and sulphate of soda. Sulphite of lime, or, better still, a stale solution of sulphide of calcium, would probably answer the purpose as well.—*J. C. B.*

Water-proof Paper.—J. Bossy prepares such paper by treating half-stuff alternately with soapsuds and a solution of sulphate of alumina, which results in producing an aluminous soap in the pulp. The sheets, after drying, are sized with glue, rosin-soap, &c. (Rep. Pat. Inv. Aug. 1846.)

Tracing Paper.—A paper dipped into a thick solution of gum arabic and pressed between two dry sheets, renders the three transparent. When dry, it is every way superior for tracing purposes, as it can be written or painted upon. Like the oiled paper, to which it is every way superior, it impresses the traced lines upon linen or paper. (Chemist, 1850.)

Tanning.—The ancient process of tanning requiring a long period of time to produce leather, numerous processes have been latterly set forth, and many of them tried on a working scale, for the purpose of shortening this lapse of time. Although the end has been attained in a variety of ways, yet the quality of the leather has proved so inferior, that the slower process is still preferred for the finer qualities. The deterioration has been nearly, but not however quite, in direct proportion to the reduction of time in tanning, so that we may hope that methods will be devised for shortening the time without losing in quality. It is true that we are not thoroughly acquainted with the exact nature and progress of the change which a hide undergoes in its transformation, but we believe, on sufficient grounds, that it consists in the simultaneous metamorphosis of the hide into a gelatinous material and its combination with tannin. In some kinds of tanning, alumina, or an aluminous salt, seems to act the part of tannin. It has been found that an elevated temperature hastens the transformation; that strong liquors, or the injection of liquors by

N 10

force, hasten the combination of tannin. The same ends appear to be also attained by the free use of lime, whereby the hide is swelled and its pores opened. The precise action of acid is not well ascertained, except that the process is shortened. These are the main principles by which a shortened process of tanning has been accomplished. Where lime has been freely used, acid liquors generally follow, and the hide is so puffed and porous, that tanning becomes expeditious; but the hide has been torn and rent asunder, and the organized structure must be necessarily impaired, and the strength and firmness of the leather consequently diminished. It will be observed that in the older processes the change was so slow that the organized structure of the skin was not impaired; that but little matter was removed from the hide, while a quantity was added to it. In accelerating the change, a portion of the matter is removed by solution while undergoing transformation, before it can unite with, and become fixed by, the tannin. Hence the greater looseness and levity of leather prepared by the more modern and rapid processes. It may perhaps be stated as an ascertained fact, that leaving the side in the vats during two years instead of one, the increase of weight and quality thereby, compensates for the loss of time, by paying a fair interest on the capital invested.—*J. C. B.*

A patentee, in Lond. Journ. xxxvi. 310, proposes a combination of the white leather (alum and salt) process, with the tanning process by means of catechu. Another (Lond. Journ. xxxvi. 319) suggests the use of sulphuret of calcium instead of lime for unhairing.

Since liming tends to lengthen tanning, by preventing the more rapid union of tannin with gelatin, Turnbull treats the hides after liming with a concentrated solution of sugar, so that the access of air is prevented during the action of the bark-liquors on the hides, and the formation of gallic acid thereby prevented. In this manner, the same amount of leather is obtained in 14 days from 100℔ oak-bark, as has been heretofore obtained in 18 months from 800℔ bark.

Tannin.—Kampfmeyer states, as a result of his compa-

rative experiments with oak-bark, alder-bark, catechu, dividivi, that sole-leather tanned with dividivi is, in dry weather, about as good as the oak-tanned, but that in wet weather it is inferior. It may, nevertheless, be used in conjunction with oak-bark. (Verh. d. Gewerbfl. f. Preussen, 1847.)

Elsner states that in Wallachia, Moldavia, and Transylvania, the root of the tormentil or septfoil is largely and successfully employed in tanning, and that its value is shown by chemical analysis, which gives 17 to 34 per cent. tannin in it.

The best method of determining, practically, the amount of tannin in a substance is that proposed by Pelouze, which is to hang a strip of hide (freshly deprived of hair and ready for the tan-vat) in a tannic solution, and keep it there until it ceases to increase in weight. This increase is tannic acid, the gallic being left in the solution.

Horse-hair, Dyed.—Previous to dyeing, it is cleaned by laying it for 24 hours in soapsuds heated to 130°, turning it repeatedly. For brown, it is laid for 12 hours in a decoction of logwood in lime-water cooled down to 120°, washed and dried. If the brown hair be dipped into water containing a little crystallized tin-salt, it assumes a violet-blue shade. To give a blue color, the hair is first mordanted in a hot solution of 2 pts. alum and 1 pt. argal, wrung out, then passed through water containing a little sulphate of indigo, washed, and dried. For red, it is laid for a ½ hour in water containing tin-salt, wrung out, laid for 24 hours in a bath prepared by boiling redwood with alum, washed, and dried at a gentle heat. (Deninger in Monatsbl. d. Gewerbver. f. d. Grossh. Hessen, 1847.)

Hair Varnish.—Williams (Monit. Indust. 1848) gives the following recipe for a varnish for converting fibrous materials into "artificial hair." It is made by dissolving 10–40 pts. hog bristles in 100 pts. linseed-oil varnish. The cloth is to be immersed in the liquid and then dried at a moderate temperature.

Horn, Dyed.—To give it the appearance of tortoise-shell, a paste of 2 pts. lime, 1 pt. litharge, and a little soda-lye is brushed on, and, after drying, brushed off again. It is the

same as the Indian hair-dye, and acts by forming sulphuret of lead with the sulphur of horn, producing dark spots, that contrast with the lighter color of the horn.

Ivory hardened.—It is said that ivory which has become friable by age, will recover its original hardness by being boiled, for some time, in a solution of gelatin.

Ivory rendered Soft and Translucent.—This process of Geisler, communicated by Dr. Elsner, is as follows. Small pieces of ivory are laid in strong phosphoric acid (spec. grav. 1.13) until they become transparent, then rinsed in water and dried in pure linen. When dry, it is translucent, and hard, but softens as often as it is dipped in warm water or milk. The time of immersion in the acid differs with different pieces of ivory. If certain parts are to retain their original character, they are covered with a varnish before immersion. The acid probably acts by forming an acid phosphate of lime out of the basic phosphate which constitutes $\frac{3}{4}$ of ivory.

Etching on Ivory.—The ivory is to be covered with wax and the designs traced with a style, and then eaten in by a strong solution of nitrate of silver made by dissolving 6 grm. silver in 30 grm. nitric acid and 150 grm. water. Exposure to light, after the removal of the wax by hot distilled water, will blacken the color of the traces. By substituting gold, platinum, or copper nitrates, other colors may be obtained.

Ivory Etched in Colors.—The ivory is coated like a copper plate, with an etching ground, a design graved through the ground, and then etched by a solution of 120 gr. pure silver dissolved in a fl. oz. nitric acid and diluted with 1 qt. water. In the course of $\frac{1}{2}$ to 1 hour, according to the depth of shade required, the liquid is poured off, the ivory washed, and dried by paper, then exposed for an hour to sunlight, and the ground removed by terpentine. The color is brown or black. Other colors are obtained by nitrate of copper, chloride of gold, or of platinum.

Caoutchouc.—The great expansion which the application of caoutchouc to various fabrics has received within a few years past, is largely, if not mainly, due to the persevering

industry and ingenuity of Charles Goodyear, of New Haven, Connecticut. During a series of years of patient investigation, he performed numberless experiments with a single object in view, viz. such a modification of caoutchouc, as would obviate all objections to its use, all defects in its properties, without impairing, and if possible, by increasing, its valuable qualities. Repeated failure did not discourage him, but seemed to nerve him the stronger in his toilsome pursuit, until at length success crowned his efforts. After he had been engaged some years in these investigations, and had already met with a degree of success which would have satisfied most persons, in the year 1841 he placed specimens of his manufactured *rubber* in the hands of one of the writers of this report, for the purpose of testing its properties under chemical agency, in comparison with the native caoutchouc. This writer has known him personally, and been acquainted with his successive improvements from that period to the present time. His first improvement, which constituted the basis of others, consisted in the discovery by himself, that sulphur, under the influence of a higher temperature than usual, imparted the wished-for properties to caoutchouc, and that when conjoined with oxide of lead, these properties were still further improved. He called the compound Metallic Rubber. All processes for *vulcanizing* caoutchouc employed in England and on the continent of Europe resulted from this important discovery of Goodyear. A fuller account of the process he pursued, was published some five years since in the Encyclopædia of Chemistry, to which reference is here made. Many other important improvements have been made under Goodyear's direction, both of a chemical and mechanical nature, some of which will doubtless be brought into successful employment, as soon as he conceives them to be sufficiently perfected. The present advanced state of the manufacture of elastic goods leads us to look onward to the time, when the manifold applications of caoutchouc, as a substitute for leather, with or without elasticity,—for various kinds of cloth, whether the coarse cloth of a tent exposed to the weather, or the more delicate fabric

upon which an engraving is printed,—its application to purposes for which no other substance can as well be employed, will all point it out as one of the valuable gifts of the vegetable kingdom to mankind. No important improvement in the method of vulcanizing, or rather sulphurizing, has lately taken place, for the use of bisulphuret of carbon, sulphuret or hyposulphite of lead, sulphuret of antimony, &c., are not improvements, but rather indifferent variations of Goodyear's processes.

Burk's process, patented in England, is to mix by grinding or rolling, 15 pts. golden sulphuret of antimony with 100 pts. India rubber, to make up cloth, &c. with this mixture, and then submit it in a boiler under pressure to the temperature of 260° to 280°. It is at least more costly than Goodyear's process, and its superiority is doubtful.

For Hancock's proposed improvements in caoutchouc, &c. see Lond. Journ. 96–104, 1849.

Kamptulicon.—Lieut. G. Walton, of the British Navy, has proposed a mixture of sawdust and caoutchouc, under the name of kamptulicon, as a lining for the interior of iron war-vessels. The inventor claims that, from its elasticity, it will immediately collapse when penetrated by a ball, and thus prevent the entrance of water. It also deadens concussion, and by its buoyancy will keep a vessel afloat though it should be riddled with shot, and moreover will prevent loss of life caused by splinters.

Guttapercha.—This remarkable product, similar in its origin and composition to caoutchouc, differs wholly from it in its external characters, being very solid and unyielding at common temperatures, having something of the character of horn, but being quite plastic at 212°, at which temperature it can be pressed and moulded into any required form, from the simple form of a tumbler or plate, to the richest carving of a picture-frame and the minute lines of a medal. E. N. Kent has observed that it dissolves in the oils of terpentine, rosin, tar, guttapercha itself, in tereben and its muriate, but that neither by precipitation nor by evaporation can the solvent be wholly removed from it again. When dissolved in bisulphuret of

carbon or chloroform, it may be precipitated unaltered by alcohol. Its solution in 16 pts. of the solvent is with difficulty rendered clear by filtration. See also Vogel's experiments, in Chem. Gaz. vi. 237.

The uses of guttapercha are evidently extending from the beautiful picture-frames, and other articles in bold relief, to more important and widely extended subjects. Its inordinate degree of toughness, with slight elasticity, imperviousness to water, slight alterability by ordinary chemical agents, and the ease with which it may be moulded by heat into any required form, and caused to adhere to itself or to other objects, constitute an assemblage of valuable properties which gives it an almost equal position with the most useful materials which man possesses. A comparison of caoutchouc and guttapercha exhibits the wonders of nature in an eminent degree. Both derived in a similar manner from the concrete juices of trees growing together in the same region, both having the same composition, both eminently resisting chemical action in a similar manner, and each dissolving or softening in similar solvents; yet one is exceedingly elastic, and extensible in every direction, yielding to the slightest force but returning to its primary form, the other resists extension powerfully, but possesses a slight elasticity at right angles to its extended surface; one, when heated only to its softening point, becomes very adhesive and gummy, and returns very slowly, in months or years, to its original elastic character, the other, when gently heated, becomes pliant and yielding like wax, and retains with unyielding obstinacy, when cold, the impressions it received while warm. We have already witnessed a vast number of applications of caoutchouc, devised by the ingenuity and perseverance of Mackintosh, Goodyear, and others; but we have yet to discover the manifold applications of which the properties of guttapercha convince us this material is susceptible, and we may be assured that neither of them will exhibit their full sphere of utility for a lengthened period of time. Its analogy with caoutchouc will doubtless hasten the development of its usefulness, but the same analogy will also

retard it in some points, by leading it too closely in the track of that substance, whereas its peculiarities should in some respects open a new path in its applications and mode of application.

The properties of guttapercha led early to the proposition to apply it to ships and other apparatus requiring to be waterproof, and Forster suggests an improvement for coating plank (Lond. Journ. xxxvi. 31), for sheathing vessels, &c.

For an account of guttapercha and its applications, see Proc. Brit. Assoc. and London Athenæum, 1849; also Amer. Journ. (2) vii. 276.

3. Adhesives.

Textile and sheet fabrics, and solid tissues, are either ornamented or united by varnishes and cements. These have either a resinous basis, or are composed of gums or glue. The solvents for resins are alcohol, or the oils, whether fat, essential, or empyreumatic; water is the vehicle for conveying gum and glue. Resins and balsams are first introduced.

Copaiva Balsam.—Posselt (Liebig's Annalen, lxix.) has examined a copaiva balsam, from South America, which is quite distinct from the ordinary kind. It has the same odor, but is lighter colored and more fluid. Spec. grav. 0.94. Becomes turbid on the addition of potassa solution or of aqua ammonia, but separates in time without having become soapy. In alcohol it is partially soluble, forming a milky liquid. By distillation with water, it yields 82 per cent. of *paracopaiva oil* ($C_{10}H_8$), the residuum being a resin, part of which is soluble and the rest insoluble in alcohol.

Rosin, or Common Resin.—Louyet (Comptes Rendus, xxiv.) has obtained, by the destructive distillation of the resin of the *pinus maratima*, two products, one of which he proposes as a substitute for oil of terpentine. One is a fat oil, and the other a very fluid essential oil. The latter, by rectification over lime to separate acetic acid, water, &c., becomes suitable for purposes both of illumination and painting. E. N. Kent,

of New York, whose researches upon this subject have been extensive, proposes an economical mode of bleaching this essence, which he has patented.

Dammara Resin.—Dulk (Pharm. Cent. Blatt, 1847), who examined this resin, found that it fuses at 165° F. and leaves 3.9 per cent. of ash. It is nearly insoluble in alcohol, potassa, and ammonia, but is taken up entirely by strong sulphuric acid and the fatty oils. Its proximate constituents are *dammaryl* $C_{46}H_{38}$, forming 13.5 per cent., soluble in ether; *alpha-resin* $C_{46}H_{39}O_4$, 24.5 per cent., soluble in dilute alcohol and not separating on cooling; *beta-resin*, 10.5 per cent., soluble in hot dilute alcohol and depositing on cooling; *gamma-resin*, or *dammarylic acid* $C_{46}H_{38}O_3$, 44 per cent., dissolved by absolute alcohol; and *epsilon-resin* $2\ (C_{46}H_{38})+HO = 7.5$ per cent.

Gold Lacquer.—3 oz. seed-lac, 1 oz. yellow amber, 1 oz. gamboge, 40 gr. red-wood, 18 gr. saffron, 30 gr. dragon's blood, 3 oz. pounded glass, 20 oz. alcohol. The powdered substances are dissolved in the alcohol on a sand-bath. The articles should receive two or three coatings, and be dried by a gentle warmth. (Mannheim. Gewerbvereinsbl. 1847, 14.) A collection of recipes for gold lacquer will be found in the Polytech. Centralblatt, and the Polytech. Notizblatt for 1846.

Copal Varnish.—See an essay on the different kinds of copal and their behavior to solvents, in Lond. Journ. xxxvi. 194.

Brilliant Lacquer for Leather.—Over 4 oz. shellac and ½ oz. lampblack in a stoneware vessel, pour 1¼℔ alcohol (of 80 per cent.), and cover it with a moist bladder. After standing in the cold 24 hours, during which it is often shaken, the bladder is punctured by a needle, the jar put in hot water, frequently shaken, and ½ oz. Venice terpentine added. The lacquer is shaken when used. (Polytech. Notizbl. 1846, 48.) It is recommended as a good varnish for boots, not affecting the leather; but repeated applications would tend to crack the leather, from the want of sufficient flexibility in the coating.

Brilliant Lacquer for Paper and Papier-maché.—3 oz. powdered sandarac are digested on a sand-bath in 12 oz. alcohol, 2 oz. elemi-resin added, previously fused in an earthen pot, and the whole digested until dissolved. This lacquer is brilliant, and rather durable. A good lacquer for colors is 3 oz. sandarac, 2 oz. mastic, 2 oz. pounded glass, 1½ oz. Venice terpentine, and 1℔ alcohol. After solution, the varnish is filtered through felt. It may be colored red by anotto, dragon's blood, or red-wood, yellow by gamboge or turmeric, and green by buckthorn berries. (Polytech. Notizbl.)

Oil Varnish.—Liebig's method of preparing a good varnish is as follows. 1℔ acetate of lead, 1℔ litharge, and 5 pints water are digested together until the reddish color of the litharge has become white, from the formation of $\frac{1}{6}$ acetate of lead, and filtered. 20℔ linseed oil, containing 1℔ litharge, is added to the filtrate, exposed to the sun, and frequently shaken, until the varnish has become wine-yellow and clear, when it is filtered through cotton. It dries rapidly. An analogous method for poppy-seed oil prescribes 4 oz. oil, 2 oz. litharge, and 2 pints water, and directs that the liquid should be poured off, 8 oz. of the oil poured on the white basic acetate remaining, and exposed to the sun until it has become colorless.

Varnish for Patent Leather.—The process followed in France for glazing leather is to work into the skin, with appropriate tools, three or four successive coatings of drying varnish made by boiling linseed oil with white lead and litharge, in the proportion of one pound of each of the latter to one gallon of the former, and adding a portion of chalk or ochre. Each coating must be thoroughly dried before the application of the next. Ivory-black is then substituted for the chalk or ochre, the varnish slightly thinned with spirits of terpentine, and five additional applications made in the same manner as before, except that it is put on thin and without being worked in. The leather is rubbed down with pummice-stone powder and then varnished and placed in a room at 90°, out of the way of dust.

The last varnish is prepared by boiling ½lb of asphalt with 10lb of the drying oil used in the first step of the process, and then stirring in 5lb copal varnish and 10lb terpentine. It must have a month's age before it is fit for use.—*Patent Journal.*

Elastic Varnish.—2 pts. rosin, or dammar-resin, and 1 pt. caoutchouc are fused together, and stirred until cold. To add to the elasticity, linseed oil is added. Another varnish for leather is made by putting pieces of caoutchouc in naphtha until softened into a jelly, adding it to an equal weight of heated linseed oil, and stirred for some time together, while over the fire.

Cement for Luting Joints of Steam Apparatus.—Serbat prepared a mastic instead of the red-lead cement used for this purpose, by thoroughly incorporating sulphate of lead, black oxide of manganese, and linseed oil. See Lond. Journ. 1849, 61.

For the preparation of a lubricating grease from rosin oil, see the Report on Serbat's process, in Lond. Journ. 1849, 58. The quantity made by Serbat in 1847 was 305,000lb, which may give some idea of its value.

Cement (*glue*).—Herberger recommends the following as an excellent cement to join metal with glass or porcelain. To 2 oz. glue, dissolved in water and boiled down to a thick solution, are added 1 oz. oil varnish, or ¾ oz. Venice terpentine, and the whole heated to ebullition to incorporate them thoroughly. The articles cemented should remain 48–60 hours before use.

A good *cement for glass*, porcelain, and pottery, which is not to be exposed to water, is to mix equal parts dry quicklime and gum arabic, in fine powder, and to moisten the whole with water or white of egg, to make a thick paste. (*Elsner.*) Quicklime and white of egg alone make an excellent cement of this kind; but the diamond cement, a dilute alcoholic solution of fish glue and resin, is far superior, although more costly, and will withstand a considerable exposure to moisture.

Emery and sand-paper, being made with glue, which is liable

to become moist and injure the efficiency of the paper, a water-proof adhesive surface is desirable, to which the grinding powder may be attached; and for this purpose it has been proposed to use a solution of copal in hot linseed oil, together with Venice terpentine, Venetian red, a little litharge, and caoutchouc. (Lond. Journ. xxxvi.)

VI. OLEICS.

Although some fatty bodies are very different from others in their chemical nature, and all of them differ from the essential oils, yet being often used in the same branch of manufacture indiscriminately, they may be embraced together as a class.

1. Oils and Fats.

By far the larger proportion of oils and fats agree in being composed of a fat acid united to a base called glycerin. The three principal acids are stearic, margaric and oleic; when stearate or margarate of glycerin predominate (the compound being called stearin or margarin), the fat is more solid, as tallow, suet, &c.; when oleate of glycerin (called also olein) is in sufficient quantity, the fat is fluid or oily, as olive oil. The chemical connection between margaric acid, which is a solid crystalline fat, and vinegar or acetic acid, and the connection between acetic acid and common alcohol, are pointed out in an essay by one of us, published in the Journ. Fr. Inst. 1848. Now since formic, acetic, and valeric acids can be shown to be derived from wood-spirit, common alcohol, and fousel-oil, which are their respective alcohols, we may infer that the higher fat acids have also their alcohols. The investigations of Brodie in wax seem to point out such alcohols and their acids. The general formula for this fat acid series, the most extended series yet developed in organic chemistry, is $C_nH_nO_4$, n being an even number (see below). No well-defined connection has yet been established between other fat acids not belonging to this group.

Cocoanut Oil.—According to Georgey (Ann. der Chem. und Pharm. lxvi.) the butter of cocoa contains the following acids:

Caproic	$C_{12}H_{12}O_4$
Caprylic	$C_{16}H_{16}O_4$
Capric	$C_{20}H_{20}O_4$
Pichuric (lauric, laurostearic)	$C_{24}H_{24}O_4$
Myristic (probably)......................	$C_{28}H_{28}O_4$
Palmitic	$C_{32}H_{32}O_4$

The *cocinic* acid of St. Evre is a mixture of capric and pichuric acids.

Stearic Acid.—Gerhardt and Laurent have endeavored to prove (Comptes Rendus, 1849) that the formula for stearic acid is $C_{34}O_{34}O_4$; that margaric acid is an isomeric modification of it, and should be called metastearic acid.

Oil of the Beaked Whale.—The train-oil of the *balæna rostrata* has recently been examined by Scharling (Journ. f. Prac. Chem. xliii.), who gives it the formula $C_{62}H_{60}O_4$. It consists principally of a liquid fat, free from glycerin, a minute portion of spermaceti and traces of other fats. Its spec. grav. is .8807 at 52°. It burns with a bright flame, and its illuminating power is in the ratio of 1.57 : 1 of common whale oil. It also burns slower and emits less smoke than the latter oil.

Bleaching of Oil by Chromic Acid.—Mr. C. Watt, Sr. (Newton's Journ. 1848, and Ch. Gaz. vi.), uses the following method for bleaching dark oils or tallow. To every ½ ton of oil take 10lb bichromate of potassa. Powder the salt, dissolve it in 4 pts. hot water, stir, and carefully add 15lb sulphuric acid, and continue the stirring until complete solution. This mixture is then thoroughly incorporated with the melted fat, previously separated from foreign matters by repose and decantation. The containing vessels should be of wood, and the temperature about 130° F. When, after much agitation, the liquid fat assumes a light-green color, the bleaching is completed, and 4 buckets of boiling water are then to be added, the whole stirred for five minutes and then left to repose for several hours, when it will be white and ready for use.

Mr. Watts, Jr., proposes to recover the chromic acid *ad infinitum*, and thus render the process very economical, in

manner as follows. Transfer the green chrome liquor, after the separation of the fat, to a tub, dilute it with water, and then add thick milk of lime until the sulphuric acid is nearly saturated; leave to repose, decant the liquor from the sulphate of lime, and carefully add to it another portion of cream of lime until the precipitation of all the green oxide, and the supernatant liquor is clear and colorless. Drain off this liquor, add fresh water, and, after settling, again decant. Repeat this washing, then transfer the precipitate to a red-hot iron slab, and keep it constantly stirred until it changes to a yellow powder. The chromate of lime, thus formed, if decomposed by sulphuric acid in slight excess, yields chromic acid as well suited for bleaching purposes as that from bichromate of potassa.

Oil-filter.—A good filter is said to be made of fine sand, charcoal, and gypsum; the sand to retain substances suspended in it, charcoal to decolorize it, and plaster to remove water. (Journ. de Chim. Med. 1846.)

Raw Linseed Oil Decolorized.—A solution of 2℔ copperas in 2½℔ water is poured into a flask containing 2℔ linseed oil, and exposed to the sun for several weeks, during which it is frequently shaken. The oil is said to be rendered limpid and colorless, and may be drawn off by a siphon or stoppered funnel.

Lubricating Oil.—Many substitutes have been proposed for the more costly oil for lubricating machinery, but hitherto with only partial success. Munkittrick's patent (Lond. Journ. xxxvi. 98) consists mainly in the addition of caoutchouc to common grease, the former being softened by spirit of terpentine; but he also uses other ingredients. For example: 10 galls. water being heated, 1℔ glue and 10℔ carbonate of soda are stirred in, 10 galls. oil or grease are next added, whereby a quasi soap is formed, and lastly, 4℔ caoutchouc, softened by terpentine, are incorporated.

Boudet (Journ. de Pharm., and Lond. Pharm. Journ. 1850), gives the following as the process by which the French *liard*, or lubricating fluid, is made. Add 1 pt. finely minced caout-

chouc to 50 pts. rape-oil, and heat until the mixture is complete. A very unctuous oil is thus formed, which remains fluid at freezing temperature, and does not clog the machines, but facilitates the motion of their parts.

Fat Oils, to distinguish them.—Heydenreich proposes (Journ. de Connais. Utiles, 1849) to distinguish these oils from each other by their odor when warmed, their color by contact with oil of vitriol, and their specific gravities. By the first process, the oil is heated in a porcelain capsule over a spirit-lamp, when the peculiar volatile odor of fish, linseed, and other oils may be detected, especially if compared in the same way with the unadulterated oils. For the acid test, 10–15 drops of the oil are dropped upon a piece of glass, underlaid by white paper, and a drop of oil of vitriol is brought in contact with it by a glass rod. If it be rape-oil, a greenish-blue circle is formed around and at a short distance from the drop, while light yellowish-brown striæ form towards the centre. The same takes place with oil of black mustard, but 25–30 drops of the oil are required. With whale oil, the color is reddish, after 12–15 minutes violet on the edge, and in 2 hours violet throughout. Olive oil gives a pale-yellow passing into greenish-yellow. Linseed oil is at first dark reddish-brown and then black.

2. *Chandlery.*—The more solid fat, stearin, is separated from the more fluid olein by pressure, to make stearin-candles, or, the fats being decomposed, the more solid stearic acid is separated from buttery or fluid acids, to make stearic acid lights. Under this head we may embrace spermaceti and wax. There is but little novelty offered on any of these points.

Stearin, &c.—To separate the solid from the more fluid fat in palm oil, lard, &c., the fats are granulated and pressed cold in bags by a powerful hydraulic press, the olein which flows out being used for soap. The contents of the bags being again granulated, and pressed between warm plates of iron, the balance of the olein with some margarin and stearin is removed. To remove color from the stearin thus obtained, it

is fused with a very little nitric acid. To remove still further all the olein, Morfit proposed mixing it with a little oil of terpentine, and then pressing.

See Morfit's "Chemistry Applied to the Manufacture of Soap and Candles." According to Heintz (Ber. d. Berl. Acad.) stearin from mutton-suet becomes transparent at 124–126°, but does not fuse before 144°.

Candles of Fats and Rosin.—A process is described in the Rep. Pat. Inv. Oct. 1850, for mixing some 20–30 per cent. of rosin with fatty bodies in the melted state, by adding sulphuric acid gradually, heating it from 12 to 18 hours so as to evolve sulphurous acid, and then submitting the dark-brown crystalline solid to distillation by heated steam. The solid and oily portions are then separated by pressure.

Wax, Test of Purity.—To test for the presence of stearic acid, Geith pours over 2 drachms wax 1 oz. lime-water diluted with 1 oz. water. If the acid be present, the liquid loses its alkalinity and remains clear. Buchner proposes fusibility and specific gravity, as an approximate test of the presence of stearic acid or tallow. Tallow fuses at 108°, yellow wax at 142°. (Buchner's Rep. xliv.)

Waxes.—Our knowledge of the composition and alliances of the waxes has been much enlarged by Brodie's investigations of common beeswax and Chinese wax. He found common wax to consist of *cerotic acid* (formerly *cerin*), soluble in hot alcohol, of the composition $C_{54}H_{54}O_4$, therefore of the fat acid series $C_nH_nO_4$; and of *palmitate of meliss-ether* (formerly *myricin*). By saponifying myricin he obtained palmitic acid and melissin, which last has the formula $C_{60}H_{62}O_2$ ($=C_nH_{n+2}O_2$), or that of an alcohol. By the action of lime and potassa on melissin he obtained the corresponding acid, melissic acid $C_{60}H_{60}O_4$. Upon examining Chinese wax, he found it to consist chiefly of cerotate of cerote-ether, $=C_{54}H_{55}O,C_{54}H_{53}O_3$, for by saponification he obtained cerotic acid $C_{54}H_{54}O_4$, and cerotin (the alcohol) $C_{54}H_{56}O_2$ ($C_nH_{n+2}O_2$). (Phil. Mag. Sept. 1848, Amer. Journ. (2) vii. 427.)

2. Saponification.

Soap-boiling consists in boiling a fat with alkali and water, whereby the fat acid unites with the alkali to form a soap, and glycerin is set free. The soft soaps usually contain the glycerin, but it is removed from the hard soaps, and remains in the saline solution. Soaps retain variable quantities of water, even to 30 per cent. and more, when they appear to be dry. Rosin is usually added to make the common yellow soaps, but it can hardly be called an adulteration, as it possesses some detergent properties.

Irish Moss and Salt in Soap.—(Lond. Journ. 1849, 37.) To a strong solution of Irish moss (1℔ to 6 galls. water), made by a short ebullition and maceration for several hours, and run through sieves, a quantity of common salt is added, 1℔ to each 4 galls., and stirred until dissolved. One ton of this mixture is combined with 5 tons of soap. The utility of this compound is not clear.

Oily Acids.—When wool is cleaned by alkali in water, a portion of fat is removed, and in order to get the oily acids again from the water, Shearman treats the water with sulphuric or muriatic acid, heats the fat acid, separated from the liquid, to 212° in a leaden vessel, saturates the free acid with chalk, adds hot water, stirs, and lets it settle for several days, when the fat can be drawn off clear. It may be reconverted into soap by alkali.

Perfumery is allied to soap-boiling, which in fact forms part of this art, since one of its most extended applications is to perfume soap. The perfumes are essential oils, sometimes solid; usually derived from the distillation of odorous plants or parts of plants. Many of them are simple compounds of carbon and hydrogen; others contain also oxygen, and a few sulphur. It is probable that we shall be enabled to make some of them artificially on a large scale; for through the interesting experiments of Wöhler and Liebig, it was shown how oil of bitter almonds was formed; through those of

Procter and Cahours, that oil of winter-green could be made artificially, and below is an account of Deville's having procured oil of lemons from spirit of terpentine.

Essential Oils.—Van Hess has given the following table of the yield of essential oils, with their specific gravities. The oils heavier than water were distilled by surrounding the still with high-pressure steam; those lighter than water by blowing steam through the vegetable matters.

				Sp. grav
Oleum anisi.......	20lb..	yielded	5¼ oz.	0.977
Ol. anisi stellati..	20lb..	"	8 "...	0.976
Ol. calam. arom..	Old oil..	"		0.984
"	55lb calamus, of a previous year....	"	12 "...	0.956
"	85lb new calamus........................	"	10 "...	0.950
Ol. carui...........	12½lb of last year's seeds...............	"	8 "...	0.923
"	25lb fresh seeds from the Eifel.......	"	17 "...	0.913
"	⅛ cwt. Saxony seeds.....................	"	6 "...	0.926
Ol. caryophyll....	10lb Amboina cloves, at 6 distillations	"	31 "...	1.040
"	8lb Bourbon cloves........................	"	21 "...	1.035
"	25lb Dutch cloves, at 8 distillations..	"	74 "...	1.033
"	¼ cwt. clove-stems........................	"	16 "...	1.049
Ol. cass. cinnam..	⅛ cwt. bruised cinnamon................	"	2¾ "...	1.035
Ol. cass. flor......	12½lb..	"	3⅛ "...	1·023
Ol. foënic..........	10lb..	"	5 "...	0.968
Ol. junip. bacc...	44lb dried ripe berries...................	"	2¼ "...	0.870
"	96lb fresh " "	"	7⅛ "...	0.862
"	53lb unripe "	"	3 "...	0.864
Ol. lavendul.......	⅛ cwt. dried flowers......................	"	2 "...	0.892

Artificial Oil of Lemon.—Deville (Comptes Rendus, 1849) has shown that the camphor produced by the action of chlorohydric acid upon oil of terpentine, when treated with potassium, yields an essential oil identical in odor, boiling point, density, and composition, with oil of lemon.

Oil of Rue.—Wagner (Journ. für Prac. Chem. xlvi.) has proven by experiments that the oil of rue (*ruta graveolens*) is evolved from cod-liver oil when the latter is acted upon by sulphuric acid, and the resulting purplish mass saturated with alkali or alkaline earth. Wagner does not consider it a product of decomposition, but adopts the theory of Gerhardt in considering it the aldehyde of capric acid $C_{20}H_{20}O_2$, and exist-

ing as such naturally in the oil. He draws the inference, therefore, that the SO_3 combines with the aldehyde, or rather with the oxide of caprinyle $C_{20}H_{19}O$, and that this compound, upon the addition of a base, is decomposed, and aldehyde separates.

Castoreum Canadense.—F. Wöhler has by recent examinations (Liebig's Annalen, lxvii.) confirmed the supposition that the odor of *castor* is due to the presence of carbolic acid. He also found that it contains salicin and benzoic acid. Carbolic acid is obtained among the products of coal-tar.

Adulteration of Attar of Rose.—Guibourt (Journ. de Pharm. 1849), after showing the unreliableness of the physical characters, as a test of purity, because of the readiness with which they may be imitated, proposes three tests for distinguishing the true attar. The usual adulterants are oils of rosewood and geranium. They may be detected as follows:

By Iodine.—The suspected attar is placed in watch-glasses, under a bell, along with a capsule containing iodine. The vapors of iodine, after some hours, condense, and form a brown areola upon the oil, if adulterated, but do not change its color, if pure. On exposure to air, the iodine volatilizes, but the color, in either case, remains unaltered.

By Nitrous Acid.—This serves only to detect the oil of geranium, to which it imparts an apple-green color; as it tinges the attar and oil of rosewood alike dark-yellow.

By Sulphuric Acid.—This reagent turns all three of the oils brown, but the attar retains the purity of its odor, while that of the oil of rosewood is rendered more perceptible; the geranium oil, at the same time, acquiring a strong and unpleasant smell.

Sandal Wood.—According to Meier, there are six different substances in sandal-wood. (Ch. Gaz. vii. and Archiv. der Pharm. lv. and lvi.)

1. *Santalic acid*, extracted by alcohol, in microscopic prisms of a beautiful red tint, soluble in alcohol and insoluble in water, and forming deep-violet salts with the alkalies.

2. *Santalic oxide*, also extracted by alcohol; a brownish

mass, soluble in alcohol of .863, but insoluble in water and cold ether.

3. *Santalide*, extracted by water; a dark-red mass, soluble in ether and alcohol of .863, but, when pure, insoluble in water.

4. *Santaloide*, extracted by water; a yellowish amorphous mass, soluble in cold water and alcohol of .863, but insoluble in ether.

5. *Santaloidide*, extracted by water; a dark-brown resinous mass, insoluble in water and ether, and only slightly so in cold alcohol.

6. *Santalidide*, extracted by water; an amorphous brown mass, soluble in water, sparingly so in boiling alcohol of .912, and insoluble in ether and cold absolute alcohol.

3. Illumination.

The fatty bodies and resins of the preceding and present classes, together with bituminous coals, are the sources of artificial light. The fats are generally used as oils, spermaceti oil, whale oil, to be burned in lamps; or the more fluid portions of fat, as lard oil, are removed by pressure, and the hard stearin remaining is formed into candles; or a stearic fat is decomposed by alkali and acid, so that stearic acid is obtained to be made into candles. Spermaceti and wax are also burned in the form of candles. Their preparation falls under a preceding division, while under the present we might consider their comparative merits as sources of light; as there is, however, little of novelty to offer in this respect, we confine ourselves to improvements in the gas manufacture, and to what are termed burning-fluids.

1. *Illuminating gas* is obtained by throwing bituminous coal, grease, or rosin, upon a red-hot surface, whereby it is resolved into new compounds by an internal combustion; into permanent gases; vapors, which condense into aqueous solutions and tar; and coke, which remains. The coke is used as fuel; the tar is either distilled to obtain ethereal oils and

pitch, or burned to make lampblack; the aqueous solutions contain ammonia, and are sometimes used to procure it; the gas is a mixture of carbohydrogens, carbonic oxide and acid, &c. The gas is freed by cooling and by lime from sulphuretted hydrogen, carbonic acid, suspended tarry matter, cyanogen, &c. Since the proportion of carbohydrogen determines the illuminating power of gas, and some coals yield too much carbonic oxide, &c., it has been proposed to pass the gas through volatile, liquid, and solid carbohydrogens, of which it will take up a small quantity and increase its luminosity: this is termed naphthalizing. Quite recently, hydrogen has been used, in a naphthalized condition, but we may doubt its success.

Coal Gas.—On the comparative value of the different kinds of coal used for illumination, and on methods for ascertaining the value of the gases, see an article by Dr. Fyfe, in Edin. Phil. Journ. xlv. and in Amer. Journ. 2d ser. vii. 77–86, 157–167.

Rosin Gas.—A variation of the manufacture of gas from rosin is patented by Robertson (Lond. Journ. 1849, 37), in which the rosin, mixed with sawdust and alkali (lime, &c.), is charged into iron cases, which are put into a gas-retort and heated as usual. The products of distillation are passed into a second retort filled with lumps of coke, brick, &c., and heated to cherry redness. To make gas alone, these products pass through a third and fourth retort, filled with brick, coke, &c., and are then washed and purified by lime. To obtain partly gas and partly oily matters, the vapors issuing from the first retort, containing coke, &c., are passed through a tank containing water, where oily matter deposits, and then through the washer and purifier. The oily products are made into a grease for machinery by mixing it with lime and finely granulated zinc. Or, the oily product may be first distilled with water, yielding a spirit, which, after several distillations with a little lime, becomes colorless and thin, and is used for illumination or for a varnish.

On water and rosin gas, see an article by Prof. Fyfe, in the Journ. Fr. Inst. (3) xx. 271, 319.

Purification of Gas.—All the sulphuretted hydrogen may be removed from coal-gas by the washers and lime purifier, but a perfect decomposition may also be effected (according to Croll, Lond. Journ. 1849) by passing the gas through a solution of sulphurous acid, whereby water is formed and sulphur deposited. The excess of sulphurous acid is removed by washers and the dry lime purifier.

Lanning's process (Ch. Gaz. viii.), which has been successfully carried out at the Chartered Company's works, is said to remove from illuminating gas every trace of ammoniacal and sulphuretted impurity. The principal agent employed is the carbonic acid of the gas, assisted by a mixture of oxide of iron and chloride of calcium. The latter is made by precipitating solution of chloride of iron with lime or chalk, and adding sawdust to the mass to render it permeable. The precipitated iron becomes peroxidized by the atmosphere during the progress of preparation. In its transit through this mixture, the gas loses its impurities in the following manner. The chloride of calcium contained in it acts by its hygroscopic property as an absorbent or solvent, and thus promotes the contact of the foul matters with the disinfecting material. The peroxide of iron takes the sulphur of the hydrosulphuret of ammonia and becomes sesquisulphuret, at the same time surrendering its oxygen to the eliminated hydrogen to form water. The ammonia set free immediately unites with the carbonic acid as carbonate, and this latter salt exchanges bases with the muriate of lime as fast as it is produced. A portion of it, however, forms sulphate with the spontaneously generated sulphuric acid.

The mixture may be repeatedly regenerated by exposure to air, and thus made serviceable for new operations. When it becomes surcharged with ammoniacal salt, the latter must be removed by washing with water. In the original mixture, the lime-salt was a chloride, whereas after usage it becomes sulphate; thus, the sesquisulphuret of iron in contact with air changes into sulphate by the absorption of oxygen, and this sulphate, reacting upon the carbonate of lime thrown down

from the muriate by the carbonate of ammonia, becomes sub-carbonate, and ultimately sesqui or peroxide of iron.

According to the inventor, the sulphuret of carbon is also removed during the operation, and the illuminating power of the gas thus augmented about 8 per cent., with but slight expense for material and a great economy as to wear and tear of apparatus.

Gas-lime.—Graham's examination of gas-lime exposed to the air for a few hours after use, was composed of—

Hyposulphite of lime	12.30
Sulphite "	14.57
Sulphate "	2.80
Carbonate "	14.48
Caustic lime	17.72
Free sulphur	5.14
Sand	0.71
Water	32.28
	100.00

In this state it is well adapted to the preparation of hyposulphite of soda, for which purpose it is extracted with water, the solution decomposed by carbonate of soda, and evaporated to crystallization. The hyposulphite of soda thus obtained may be used for the daguerreotype, and might possibly be used instead of common salt to extract silver from its ores. By proper calcination, gas-lime may be converted into a mixture of nearly equal parts of sulphate and carbonate of lime, in which state it may be employed in agriculture and other arts. (Rep. Pat. Inv. 1845.) Elsner draws attention to its value for removing hair from hides.

Naphthalizing Gas.—Among the many patents for naphthalizing gas, is one in Lond. Journ. xxxvii. Aug., in which the heat of the burning jet is communicated by metal to a vessel containing a hydrocarbon. The gas, in passing through this vessel, takes with it a portion of the hydrocarbon, passes into a sphere over the jet, where it is heated, and then passes out at the jet. It is supposed to yield a whiter light. There

are other inventions for the same purpose, and doubtless some will be made of great practical value; but it would be much more desirable that gas, capable of yielding the fullest intensity of light, should be made at the gas-works. The consumer should be saved the trouble of making his own light. Whether there be any advantage in heating gas previous to its combustion in the naphthalizing process or not, we offer a suggestion by way of improvement. The vessel to be heated over the jet might be concave underneath, provided with a tube passing off from the highest point of the concavity into the open air, or chimney, so that it would carry off the products of combustion. The heated vessel might be a double cylinder or a cylindrically wound spiral tube.

Hydrogen for Illumination.—Various processes have been devised or adopted for obtaining light by means of hydrogen: and this gas is obtained for the purpose by one of three methods, in each of which cases water is decomposed, by incandescent iron or coal, or magnetic force. 1. Vertical iron pipes are filled with scrap-iron, and heated externally to a high temperature; steam is introduced, forming oxide of iron and liberating hydrogen, which passes into a gas-holder. In order to reduce the oxide of iron to the metallic state, to be again subjected to the action of steam, carbonic oxide gas is passed through the heated pipes, and becomes carbonic acid, which escapes. The carbonic oxide is obtained by passing the waste gases of the fire through a fire or ignited carbon. Instead of carbonic oxide, carburetted hydrogens may be employed, such as tar, &c.

2. Another method for obtaining hydrogen, mixed with carbonic oxide and other gases, is to pass steam through ordinary gas-retorts charged with carbonaceous matters, brought to a state of high ignition, whereby these gases are generated together with carbonic acid. A purifier serves to remove the carbonic acid from the combustible gases.

3. By means of a magnetic battery, hydrogen and oxygen are separately liberated from decomposed water.

In order to utilize the hydrogen, &c., obtained bv any of

these methods, the flame as it issues from a jet may be directed upon a wick of fine platinum wire, whose incandescence will produce the desired illuminating effect. Another method is to naphthalize the hydrogen, i. e. to pass it through a liquid or over a solid hydrocarbon (such as naphtha or naphthalin), or to mix it with the vapor of a hydrocarbon, in all which cases its illuminating property depends on the same causes as in all ordinary cases of combustion for light, viz. the inflammation of hydrogen and the precipitation and momentary incandescence of carbon in the flame.

2. *Burning-fluids.*—These are generally solutions of camphine (purified spirit of terpentine) in alcohol, and are burned in lamps constructed for the purpose. Their danger has been pointed out from year to year by one of the writers, in public lectures delivered in the Franklin Institute, in Philadelphia; yet such is the neatness of these illuminating liquids, their convenience and brilliancy, that they continue to be used until a serious accident awakens the public to a sense of their danger. But the disaster serves only to deter those from their use who were more immediately affected by it. There is no doubt that burning-fluids may be safely used by those who understand the conditions of their explosiveness, or who exercise care in their use; but since their tendency to explosion cannot be prevented, and since knowledge and care will not generally attend their use by the public, they should be abandoned.

Let us not however abandon the idea of finding a liquid which shall possess the requisite qualities of cleanliness, cheapness, illumination, and freedom from danger. Sperm-oil possesses the last two qualities; burning fluids the first three; lard-oil is cheap and free from danger, but is not cleanly, is too liable to congeal in winter, and is apt to clog the wick. Naphtha is very little, if at all, liable to explosion, but it contains an excess of carbon, and it is too apt to smoke when burned in an ordinary lamp. Since sperm-oil has a high illuminating power and is free from danger, we may yet hope to discover a liquid which shall possess these properties to-

gether with cleanliness and cheapness combined. May not such a liquid be found among the products from the distillation of coal, to be used either by itself or in conjunction with other substances?

3. *Apparatus for Illumination.*—We have nothing novel to present in relation to lamps and jets, except a remark upon reflectors.

Reflectors are found to increase the ordinary effect of a light in proportion to the perfection of their reflecting surface and their approach to a parabolic form; but, being constructed of metal, they are expensive. Kempton (Lond. Journ. 1849, 330) proposes making earthenware reflectors of a good form, and then lustring their reflecting surface in the usual manner. Clay-ware is undoubtedly an excellent material for giving a good form to a reflector, as it is readily and cheaply made, and retains its shape tolerably well during burning. But the new method of precipitating silver from solution, with a brilliant surface, might advantageously be substituted for the method usually adopted for lustring pottery with silver.

VII. SITEPSICS.

THE present class embraces arts which are exclusively confined to the preparation of food, or which prepare substances largely used in the preparation and preservation of food, both solid and liquid, and likewise used in the arts generally.

1. PREPARATION OF FARINA AND SUGAR.

Flour, starch, and sugars, are employed both as food and in the arts.

1. *Starch* is extracted from roots, as the potato, arrow-root, or from grain, wheat, rice, corn, by washing over and collecting the finely suspended sediment. There are different kinds of starch, but even the same kind, as that obtained from the above-named substances is supposed to be, differs in its properties so far that it is desirable to distinguish one from the other. The form of the grain under a powerful microscope is one mean of distinguishing them, and probably the best.

Starch, Wheat and Potato.—Redwood has given the following method of distinguishing them. If wheat-starch be ground well in a mortar with water, then filtered, and the filtrate tested with tincture of iodine, it strikes a yellow or reddish, but not a blue color, whereas potato-starch, similarly treated, strikes a blue color.

Instead of soda-ash liquor to steep grain in, it is proposed to use quicklime and salt. (Lond. Journ. xxxvi. 391.)

Amidulin.—Schulze applies this name to a substance of the same elementary composition with starch, and forming the transition substance preceding all the transformations of starch into dextrin. It is perhaps identical in composition with Jacquelin's amylum granules; is soluble in hot and insoluble in cold water, and reacts with iodine like starch. (Journ. für Prac. Chem. xliv. and Ch. Gaz. vi.)

Bleaching Gums.—Picciotto describes a process for decolorizing Arabian gums (Lond. Journ. 1849), by dissolving them in a strong solution of sulphurous acid, distilling off part of the acid, and precipitating the balance by carbonate of baryta, and, after filtering, evaporating to dryness. Or, the gums may be decolorized and cleansed by adding hydrated alumina to their solution, filtering and evaporating. If the gums are to be used for medicinal or alimentary purposes, the use of baryta is highly objectionable, and indeed for most purposes the decolorization is a matter of minor importance.

2. *Sugar.*—When starch is acted upon by sulphuric acid or diastase in water, it is converted into a sugar, called starch-sugar, which seems to be identical with grape-sugar. Cane-sugar treated with acids is resolved into the same kind; but we have not as yet succeeded in producing cane-sugar from grape or starch-sugar. There is room for extended observation in the changes suffered by the sugars, both in relation to science and to practice.

Tests for Sugars.—G. Reich thus distinguishes between different kinds of sugar. (Gewerbvereinsbl. d. Provinz Preussen, 1846.) If a hot concentrated solution of bichromate of potassa be added to molasses (cane-sugar molasses), in a test-tube, and heated to boiling by a spirit lamp, an energetic action takes place between them after removing the flame, until the liquid has assumed a beautiful green color from oxide of chrome, which is rendered more distinct by dilution with water. Starch-molasses produces no change whatever, under similar circumstances. Even when common molasses is mixed with $\frac{1}{8}$–$\frac{1}{3}$ starch-molasses, no change is produced, or if it be, it does not exhibit the fine green color of pure cane-molasses. A solution of the bichromate is not acted on by syrup (a solution) of cane-sugar, and hence molasses-sugar shows itself distinct in kind from the two others.

A solution of nitrate of cobalt is, according to Reich, a good mean of distinguishing cane and grape sugars. A strong solution of cane-sugar, treated with fused potassa, heated to

ebullition, diluted with water, and then treated with a few drops of nitrate of cobalt solution, yields a bluish-violet precipitate, which after some time has a greenish color. A concentrated solution of starch-sugar, similarly treated, yields a dirty, light-brown precipitate; or, if dilute, remains clear. A very small quantity of starch-sugar contained in cane-sugar prevents the violet precipitate by nitrate of cobalt.

Chevallier tests the presence of starch-sugar in cane-sugar by warming the solution with caustic potassa, whereby a greater or less quantity of the former produces a red or yellow coloring. According to Cotterau, all the caustic alkalies, including ammonia, produce this effect,—even their carbonates, but not their bicarbonates,—and hence he proposes starch-sugar as a test for the presence of neutral.

Maumenè (L'Institut, No. 846, and Silliman's Journ. 1850) proposes bichloride of tin as a reagent for detecting the presence of sugar in urine; the test-cloth is made of white *merino*, saturated with diluted tin solution, drained and dried in a water-bath. This cloth, when spotted with urine and held over a heated coal, turns black in the moistened places if sugar is present; whereas the stain of ordinary urine is not darkened. The reaction is due to the dehydration of the sugar, highly carbonated caramel being formed.

The author suggests the possibility of forming a useful brown pigment by the above reaction.

Quantitative Test for Cane-sugar.—Peligot's method depends upon the definite constitution of sugar-lime, its greater solubility in water than lime alone, and the unalterability of this solution by heat. Soubeiran had found that sugar-lime consisted of 3 eq. lime to 2 eq. sugar, *i. e.* 84 pts. lime to 342 pts. sugar, or 1 : 4. 10 grm. sugar are dissolved in 75 cub. centimetres water, ground up with 10 grm. slacked lime, filtered, and again filtered through the lime. 10 cub. cent. of the filtrate, diluted with 2–3 decilitres water, and tinctured with a little litmus, are carefully neutralized by a measured volume of dilute sulphuric acid (21 grm. oil of vitriol in 1 litre water), and the quantity of acid used noted. It gives the

quantity of lime neutralized, and from the above proportion the quantity of sugar present.

If cane-sugar is to be examined for starch or grape-sugar, one test is made as above, and another test in which the liquid is heated to 212°, and then, when cool, tested with the acid. The lime solution with cane-sugar becomes cloudy by heat, but clarifies on cooling, while, if grape-sugar were present, it becomes brownish-yellow, and requires much less acid for neutralization. Indeed, a decilitre of starch-sugar solution requires 4 cub. cent. of the test-acid, or just as much as lime-water itself. Cane juice may be similarly tested after concentration to 6–8° Beaumé. (Le Technologiste, 1846.)

One of the best means of determining the quantity of cane-sugar present in a solution is an instrument for showing circular polarization in liquids, a full description of which will be found in a Report to Congress by Prof. R. S. McCulloh, made several years since.

Honey.—Soubeiran's (Comptes Rendus, 1849) examination of honey proves that it consists of—1. Glucose, or granular sugar; 2. A right-rotating sugar, alterable by acid; 3. A left-rotating sugar. In the original paper, the author has given some distinctive characteristics of each, and promises the results of further investigations as soon as completed.

Purification of Honey.—André's method of purifying honey is simple, and is said to be efficient. Three sheets of white bibulous paper are doubled up and put into 25lb honey, diluted with half its weight of water, and the whole boiled over a gentle fire, until the paper is dissevered into a pulp. After cooling, the liquid is filtered through a woollen cap or cone, and evaporated gently to the consistence of honey.

Refining Sugar.—Much has been lately said, and some patents issued (Lond. Journ. Sept. 1850) for clarifying and defecating saccharine solutions by the use of salts of lead, and ingenious processes have necessarily followed for removing from the solutions every trace of lead. But we must express an unqualified disapproval of all poisonous materials in the preparation of substances used as articles of diet. The ma-

nufacturer might at first test his liquors and sugars with all possible care, to insure the removal of every trace of lead, but can he be sure that the same nicety will be observed when he transfers this operation to workmen? If a chemist were employed, might not his tests sometimes deceive him? Now, it may be shown that a very minute dose of lead, frequently repeated, will produce deleterious effects on the system; and yet such traces are apt to elude the vigilance of even an experienced chemist, when he is called upon to repeat his tests day after day. In the patent referred to (Lond. Journ. Sept. 1850), the collection of sulphite of lead as a pigment is too trivial to notice further.

Acetate of alumina may be safely used in defecating saccharine solutions (see Oxland's patent, Lond. Journ. Sept. 1850), but whether efficient or not, is to be tried. It is probable that it will answer a good purpose in part, from the acknowledged effect of aluminous solutions. In the above patent, the remainder of alumina is thrown down by a solution of tannin. The two substances are stated to be used either before or after neutralization by lime in the case of cane juice or beet-root juice. The acetate of alumina is easily made by precipitating sulphate of alumina by alkali, washing thoroughly and dissolving the moist precipitate in vinegar. It is stated that, on trial, 4℔ of alumina were sufficient for one ton of sugar.

Another patented process (Rep. Pat. Inv. July, 1850) for clarifying cane juice and sugar solutions, is the use of sulphate of alumina with chalk and silex. The process seems to be not well digested, and there is a liability of leaving some soluble sulphate in solution, which tends to injure sugar upon evaporation.

Extraction of Sugar.—Melsen's novel process (Gard. Chron. 1849) for extracting sugar from cane juice, consists in the use of sulphurous acid combined with lime, forming a bisalt. Its presence arrests the action of the air, and thus prevents the development of any ferment. In accomplishing so much, it obviates all the difficulties heretofore experienced, in the

manufacture of sugar, by the too rapid decomposition of the crude juice, in warm climates.

It is to be poured in cold solution upon the cane, as it passes through the mill, so as to insure its intimate mixture with the expressed juice. Here it exerts its antiseptic property, and also, by its great affinity for oxygen, intercepts the action of that gas upon the constituent of the juice. Its influence does not, however, stop here, for when the mixture is heated to 212°, the caseum, albumen, and analogous nitrogenous matters separate as a coagulum, and the liquid becomes materially blanched. Thus it acts also as a defecating and bleaching agent. It likewise prevents the formation of any new coloring matter by the action of air upon the pulp, insures a more perfect crystallization without the necessity of haste, decreases the amount of molasses, and yields nearly double the quantity of sugar obtained by the old methods.

The sulphurous acid, in exerting this beneficial influence, absorbs oxygen and becomes sulphuric acid, and as this latter would transform the cane into grape-sugar, the lime base is necessary to neutralize and convert it into insoluble sulphate of lime as fast as it is formed.

The sulphurous taste adhering to the sugar may be removed by crushing and exposing it to the air. A more effectual way is to refine it until its weight is decreased one-tenth. A very white and pure sugar is thus obtained.

It may be observed, in regard to the reason given for having a *salt* of sulphurous acid, that, if the acid were oxidized, we would have, it is true, the insoluble sulphate of lime, but also free sulphuric acid. According to Lüdersdorff this free acid is not injurious.

The English patent for Melsen's process appears in the Lond. Journ. xxxvi. 229. The accompanying propositions and claims, for the use of baryta or oxide of lead, are objectionable, for the reasons stated below.

Lüdersdorff's method, especially applicable to beet-sugar, is based upon the fact, determined by experiment, that juice contains two kinds of extraneous matters, of opposite chemical

relations. The use of both an acid and an alkali are therefore required for effectual defecation.

The freshly-rasped pulp is to be mixed with $\frac{1}{2000}$ of its weight of sulphuric acid. All oxidation (?) is thus prevented and the quantity of juice increased, while the pulp retains its whiteness. Three per cent. of plastic clay is added to the juice to remove its cloudiness, and at the end of twelve hours separated by filtration. The filtrate, which runs through perfectly limpid, is entirely proof against viscous fermentation, but still contains foreign matters, which are to be removed by the usual process of heating with milk of lime. The juice, thus defecated, yields by evaporation and crystallization, a very fair sugar without the use of boneblack.

Phosphoric would be preferable to sulphuric acid, were it less costly. The use of the latter is attended with several serious disadvantages; one of which is the difficulty in removing the sulphate of lime formed, and another in preventing injury to the juice at the temperature 167° F. required for its rapid filtration. Both of these might probably be obviated by the substitution of phosphoric acid. See details in Lond. Journ. xxxvi. 403.

Sugar-filters.—For filtering saccharine and other liquids, a patent appears in the Lond. Journ. xxxvi. 107, in which a cycle of filters is used, the bottom of each being connected by a pipe with the top of the next. The first liquor is run into that one longest in use, and passes successively through the others. One is always out of use, and being prepared with a fresh charge of boneblack.

A filter of cotton for sugar solutions is described in Lond. Journ. 1849. About 2½ ℔ of raw cotton are drenched with hot water and allowed to remain in water for 12 hours. A little chalk and starch, with a boiling heat and skimming, are used to remove a portion of the impurities. The drenched cotton is then put on the slat-bottom of a cylinder or conical filter and a little water poured through, which is run off by a cock under the false bottom. The sugar solution is next poured on the filter, and, after passing through, is immediately

boiled down to crystallization. The sugar adhering to the cotton is washed out and added to the blow-up; the impurities remain in the cotton.

A late improvement in refining sugar is the employment of centrifugal force for driving out the syrup from the crystalline grains of sugar. For this purpose, the syrup, with the grains formed in it, is led into a drum fixed on a vertical shaft, with its circumference formed by wire-gauze. The drum being made to revolve with rapidity, 2000 times per minute, the liquid mass is driven by centrifugal force to the circumference, where the grains are detained by the gauze and the liquid oozes through on the outside. It is a constantly acting force, and it would seem as if the same effect might be produced by a broad and shallow filter, the lower part of which should be partially exhausted by an engine.

2. Fermentation.

Practically, we have only to consider the manufacture of alcohol and vinegar, but the consideration of fermented liquors generally may be introduced. Vinegar is now chiefly made from alcoholic liquids by simple oxidation, and the process is a beautiful gift from chemical science to the arts. As there is nothing new in relation to the vinegar process, we offer a few observations in regard to the nature of fermentation, to alcohol and wines. We notice a large work on Fermentation, issued in Germany, entitled "Gährungschemie in 3 Bänden, 1845, und 4ter (Supplement) Band, 1847," by Prof. C. Balling.

Fermentation.—According to Helmholz's experiments, substances capable of undergoing fermentive changes in common air, do not suffer them if the air have been previously ignited; from which he drew and confirmed a formerly advanced opinion that fermentations arise from the exhalations of matter in the act of fermentation, whose germs or seed are conveyed to fresh matter capable of these changes, and impart to it their own character; and that these germs being destroyed by heat, such air will not produce fermentation.

Mitscherlich's experiments lead to a similar conclusion. (Berzelius Jahresb. 1846.) The fermentable substances were put into flasks with water, and boiled to destroy the vitality of seed. One flask was left open, and the other closed with filtering paper, pasted tightly around the edges. The open flask soon showed signs of fermentation in the formation of mould; while the other did not exhibit any such change in the course of months, the paper apparently filtering off the germs from the air which entered the vessel.

Döppning and Struve, repeating Helmholz's experiments, drew the conclusion that all nitrogenous substances undergo decomposition, even in air previously ignited, and that it is chiefly prevented or diminished by a boiling temperature. They also observed that paper, straw, and other porous bodies may be fermented without the presence of a ferment, but that the resulting product is butyric acid and not alcohol. The same fermentation occurs when solutions of sugar are brought in contact with powdered charcoal or sulphur, but in the latter case, a little tartrate of ammonia should be added. (Bullet. de St. Petersbourg, 1847.)

Action of Ferment on Sugar.—Dubrunfault's examination of the changes suffered by cane-sugar, in the fermenting process, previous to the formation of alcohol and carbonic acid, led him to the following conclusions. The altered cane-sugar (or its analogous grape-sugar or fruit-syrup) is not a simple variety of sugar; only a certain quantity of it becomes glucose by crystallization, the residue polarizing to the left with the same power that the separated grape-sugar polarizes to the right. In the vinous fermentation of the altered sugar, that which disappears in the first part of the process is optically neutral, while the sugar which disappears last polarizes strongly to the left. No one sugar is exclusively decomposed before another in fermenting mixed sugars. The sugar produced from starch, by the action of malt, is not identical with grape-sugar; for the former is less soluble in alcohol, less liable to change by ebullition, or the alkalies, and its polarizing power is three times that of the latter. The optical deflecting

powers of such quantities of grape-sugar solution, kept for a long time, of freshly dissolved grape-sugar, of starch malt-sugar, and of dextrine, as will all give the same quantity of alcohol, are in the ratio of 1 : 2 : 3 : 4. (Journ. Prac. Chem. xlii. 418.)

Alcohol and Water.—Townes gives the following results of his experiments to determine the specific gravity of mixtures of alcohol and water. Column A shows the percentage of alcohol by weight in the mixture, and B the spec. grav. at 60°.

A	B	A	B	A	B	A	B
5	0.9914	30	0.9578	55	0.9069	80	0.8483
10	0.9841	35	0.9490	60	0.8956	85	0.8357
15	0.9778	40	0.9396	65	0.8840	90	0.8228
20	0.9716	45	0.9292	70	0.8721	95	0.8089
25	0.9652	50	0.9184	75	0.8603	100	0.7938

Alcoholometers.—Two instruments have been invented for determining the proportions of alcohol in liquids containing substances in solution which increase the spec. grav. of the liquids, in which case the indications of a hydrometer are not to be relied on. The principle of their use depends upon the lower boiling point of a mixture in proportion to the quantity of alcohol it contains. They are termed *Ebullioscopes.* The instrument employed by Brossard-Vidal is a large thermometer; the mercury in the tube carrying a float, from which a cord passes over a pulley and is counterpoised by a light weight. An index is attached to the roller, which points to degrees on a graduated scale, according as the pulley revolves, *i. e.* as the level of mercury alters, when the liquid boils.

Conaty's instrument is a common thermometer, with a scale attached, which directly indicates the proportion of alcohol contained in a liquid into which it is immersed during ebullition. The movable scale may be also adjusted for barometric variation, so that further corrections are avoided. Both instruments have been reported to the Paris Academy as capable of indicating 1 or 2 per cent. of alcohol in a liquid, but that of Conaty is thought to be the most convenient. (Comptes Rendus, xxvii.)

Ure has constructed an instrument of the same kind, similar in principle to that of Conaty. (Phar. J. Trans. vii. 166.)

Dilatometer.—Silbermann (Comptes Rendus, 1848) has invented an instrument for determining the relative quantity of each liquid in mixtures of water and alcohol. It is called a dilatometer, and derives its principle from the fact, that the dilatation of alcohol is three and a half times greater than that of water, at temperature from 77° to 122° F. For example, if the bulb of a thermometer-tube be over-filled with alcohol and heated to 122°, it will be seen that the liquid rises in the tube three and a half times higher than would the same quantity of water under like circumstances. So, also, any mixture of the two would give a mean point of dilatation, approximating that of the alcohol or water, according as either may preponderate. Thus, by making the water point 0°, and noting severally and consecutively the degree of dilatation of a series of 100 mixtures, commencing with water 99 and alcohol 1, and ending with alcohol 100, water none, a centesimal alcoholometric scale may be graduated so as to show at a glance the proportion of either in any mixture of the two liquids.

Other scales may be adopted upon the same principle, to determine the ratios of any other two liquids differing in their degree of dilatation.

The dilatometer is particularly applicable for testing wines. The particulars as to its construction and use are given in the original paper.

Distilled Liquors and Fousel-oil.—To free them readily from fousel-oil, Peters recommends a hogshead with a false bottom to be half filled with well-ignited charcoal, the top of this to be strewed over with 10lb boneblack, and 5lb black oxide of manganese, and the whole to be filled up with charcoal. The hogshead is to be filled with brandy, whisky, &c., which is to remain in it for 3 days, and then drawn off. That which first runs off cloudy is to be redistilled, but this operation will not be again required. The vessel thus prepared will last 12–15 months.

Butyric Ether.—This ether is used for imitating rum, on account of its agreeable apple-odor. To obtain it dissolved in alcohol, Wöhler recommends (Pogg. Ann. xlix. 360) saponifying butter with strong potassa-lye, dissolving this soap in the least amount of alcohol, by the aid of heat, adding to it a mixture of alcohol and sulphuric acid until it has a strong acid reaction, and distilling it as long as the distillate possesses the apple-odor.

Sulphuric Acid in Wines.—Lassaigne (Ann. de Ch. et de Phys. xxi. 119) proposes a very simple and delicate test of the presence of sulphuric acid in wines. When a piece of white-glazed paper, containing starch, is touched with pure wine and dried at a gentle heat, no spot is produced; but if sulphuric acid be present, even to the extent of $\frac{1}{1000}$, the spotted portion reddens and becomes brittle between the fingers before the white paper becomes at all colored. Pure wine leaves, by spontaneous evaporation, a violet-blue spot, but if containing 2–3 thousandths of sulphuric acid, a rose-red spot.

Effect of Oak-casks upon Wines.—Famè (Journ. de Pharm. et de Chim. xiii. and Millon and Reiset's Annuaire, 1849) gives the following conclusions, based upon the results of a series of analyses.

1. That the oak woods used by the coopers for making wine and liquor casks are the same in composition; though the proportions of the ingredients vary with the place of growth of the tree.

2. That the soluble principles of oak-wood have an appreciable action upon liquors, and particularly upon wines.

3. That this action is more evident upon white than upon red wines; more so upon light and delicate than upon colored and coarse wines.

4. That American oak contains less soluble matter than other kinds.

5. That casks made of American, Dantzic, or Stettin oak, have, in general, the least action upon spirituous liquors. The two latter even, sometimes, improve the quality of the wines.

6. That alkalies increase the color and solubility of the ex-

tractive matter of the wood; and the mineral acids, on the contrary, weaken them.

Sweetening of Sour Wines.—Liebig (Ann. der Chem. und Pharm. lxv.) proposes to remove the acidity of sour Rhine wines, by means of a concentrated solution of tartrate of potassa, which precipitates the acid as insoluble bitartrate. The proper proportion of the salt varies with the wines, their age and quality, and must be determined by the intelligence of the operator. This mode is far preferable to neutralization by lime or potassa, as it leaves no salt in the wine to impair its flavor.

Malt Liquors.—On the amount of inorganic constituents in ale and porter, see Phil. Mag. xxxiii. 341, and Amer. Journ. (2) vii. 102.

3. Culinary Arts.

1. *Beverages.*—Doubtless the most important of these is water, which we have considered in regard to manufactures under Chemics, and now present it in its character of a beverage. Soft water, taken on shipboard, frequently undergoes several distinct fermentations, after which it appears to be no longer liable to alteration; but the character of these changes has not been studied. Probably all sweet waters, and perhaps all waters on the globe, contain more or less organic matter, generally a minute quantity, dissolved in them, and the putrefactive processes observed in a ship's supply of water is doubtless due to this cause; for if caused by other organic matter, the cessation of putrefaction would not be observed, as the same cause would continually present itself. How to remedy the defect is an important question.

Perinet has found that binoxide of manganese will preserve the sweetness of water for years. 60 gallons of water, containing 3℔ of the powdered binoxide, remained perfectly sweet and clear for seven years in a wooden vessel. (Journ. de Chim. Medic. April, 1846, 301.)

Purification of Sea-water.—According to Cardan, sea-water

is entirely deprived of its nauseous taste by infiltration through powdered charcoal. A siphon-shaped vessel is recommended —the coal to occupy the long arm. (Lond. Athenæum, 1850.)

Action of Water upon Lead.—Horsford (Procdgs. Amer. Acad. Arts and Sciences) classifies drinking-waters, as follows:

1. Open waters, as ponds, lakes, and rivers, having their sources in rainfalls and surface drainage.

2. Waters concealed from sunlight, as wells, and certain springs, formed by infiltration through earthy and rocky strata.

The latter, except in winter, are colder and contain a greater amount of gases than the former. They also hold, in solution, more inorganic matter, especially nitrates and chlorides, but have less organic matter than open waters.

The results of his experiments authorized the following conclusions. That neither dry air, or water freed of air, have any oxidizing influence upon lead; that metal being acted upon proportional to the amount of free oxygen in solution. That the nitrates are partially reduced by lead, and that both they and the chlorides facilitate the solution of the plumbic coating formed in service pipes. That the presence of animalculæ or vegetable matters does not impart corrosive properties to water; for these substances being most abundant in summer, the oxygen arising from their decomposition (?) is expelled by the natural heat of the water. Moreover, the escape of gas and air is promoted by the presence of insoluble organic matter, whilst that portion of the latter which may be in solution consumes the dissolved oxygen and reduces the nitrates. Organic matter, therefore, rather impairs the solvent action of water upon lead.

Lead does not reduce iron oxide, nor is it corroded by alkaline chlorides, in the absence of air. Pure water, as a general rule, possesses a greater solvent power than when salts are in solution. All natural waters produce more or less corrosion in the interior of lead conduits, but the coating at first formed is entirely insoluble; contact with water and carbonic acid, however, soon increases its state of oxidation, and it then becomes soluble in 7 to 10,000 parts of pure

water. When sulphuric acid, oxide of iron, or organic matters are present, this oxide unites and forms with them a highly protective covering.

Paraguay Tea.—A decoction of the leaves of *Ilex Paraguayensis* is used in South America as a beverage, in place of tea and coffee, and hence its vulgar name of "Paraguay tea." According to Stenhouse and Rochleder (Ann. der Chem. und Pharm. lxvi.) its crystalline principle is identical with caffein, and its acid gives the same reactions as caffeo-tannic acid.

Chicory Coffee.—This article, originally manufactured in Holland, a century since, was first made in France in 1801, by Orban and Giraud. Since then, it has become an important object of commerce; the exports from 1827 to 1836 having reached 458,971 kilogrammes. The home consumption alone amounts to 12,000,000 pounds. It is used alone, or mixed with coffee, to which it imparts a bitter taste, and at the same time, it is said, modifying its stimulant action. It is frequently adulterated with coffee-grounds, brick-dust, earthy matters, roasted acorns, corn, haricots, and peas. Of these fraudulent mixtures, those containing starch may be detected by means of iodine-water. The coffee-grounds are recognised by throwing a pinch of the suspected chicory, previously dried, over a water-bath, upon the surface of water; the chicory absorbs water and sinks, the coffee-grounds float.

The mode of preparing chicory coffee is, to collect the plant in the spring, and to strip and wash the roots. These roots are then divided into longitudinal strips, which are in turn still further reduced in size by being cut transversely, and dried in a heated chamber. The drying is facilitated by frequent stirring, and the root thus prepared takes the name of *cossetes.* After roasting in cylinders, 2 per cent. of butter is added and the machine rotated several times, in order to give lustre and the appearance of coffee to the chicory. Grinding between cylinders, sieving, and coloring with *rouge brun de Prusse*, complete the operation.

On chicory coffee, by Chevallier, see Amer. Journ. 2d ser. viii. 441, and Chem. Gaz. 1849.

Alcoholic Drinks.—Bouchardat and Sandras (Ann. de Chim. et de Phys. 1847, and Ch. Gaz. vi. 121), with a view of determining the manner in which alcohol is absorbed by and the changes which it undergoes in the system, performed a series of experiments, the results of which go to prove that it is absorbed by the veins, and not by the lacteals; and, excepting a minute portion escaping by the lungs, it is entirely oxidized into carbonic acid and water, either directly or by passing through the intermediate stage of acetic acid.

2. *Preparation of Food.*—On this subject, much cannot be yet offered by the chemist; but, with his wonted spirit, Liebig has led the way in this branch of the chemical arts.

Index of Nutrition.—Dr. A. Vœlker's essay, presented to the British Association at their late meeting (1850), showed that the quantity of nitrogen, considered as an index of the nutritive value of food, had been incorrectly estimated, in consequence of a portion of it existing in the form of ammonia.

Detection of Corn-meal in Wheat-flour.—La Grange (Journ. de Chem. Med. iv. 339) takes of the suspected matter 2 grm. sifts and places it in a test-tube, and then stirs in 4 grm. nitric acid. After this it is diluted with 60 grm. water, and then a solution of 2 grm. carbonate of potassa in 8 grm. water is added. After the escape of carbonic acid, if there is no corn present, the subsiding flocculæ will be yellow; otherwise they will be intermixed with orange-colored particles. This test serves for the detection of as little as 4 per cent. of indian-meal.

Horse-chesnut.—Flandin (Comptes Rendus, xxvii.) proposes to remove the acrid resin and bitter taste of the horse-chesnut, by kneading the powdered kernel with $\frac{1}{50}$ to $\frac{1}{100}$ of its weight of soda, and then washing out with water.

Cooking of Meat.—Liebig's researches (Ann. Ch. Pharm. lxii. 257) upon the juices of flesh have furnished valuable results, which are full of general interest, because of their practical application. All the nutritious portions of flesh may be extracted by finely mincing and exhausting it with cold water. The liquid, thus obtained, contains creatin, some cre-

atinin, albumen, coloring matter, inosinates, lactates, alkaline phosphates and chlorides, with other salts. It is to be heated over a water-bath in order to coagulate the albumen, which carries with it the coloring matter. The liquor is then strained, and if the constituents are to be separated, treated with caustic baryta to precipitate free phosphoric acid, which would, otherwise, cause the deposit of a brown sediment during the subsequent evaporation. If the liquor is intended for soup, instead of being strained, it may, after maceration in the cold, be gently boiled with the meat for a few minutes, and strained. The clear liquor then only requires seasoning to become palatable broth, imbodying all the nutriment of the flesh. The residual meat is sinewy and without taste or nourishment. Gelatine forms but a very small portion of the dissolved matters; and Liebig confirms Proust's view that soup does not derive any taste or nourishing power from it. The flavor is due to the soluble constituents of the meat, which exist in it ready formed, and are not generated during the process of boiling. By a gradual and carefully managed evaporation in shallow pans, the liquor, prepared as above, may be converted into a brown "extract of flesh," retaining the savory odor of roast-beef. It may be called portable soup, for it can be preserved any length of time, and gives, with 30 pts. water and proper seasoning, a most palatable and nutritious broth.

From these facts, it follows that the proper way of boiling meat, so as to insure the retention of its flavor and nutriment, is to plunge it directly into boiling water, and after a few minutes to reduce the temperature of the liquid to 158° by the addition of cold water. The outer portion of the meat is thus hardened, and a gentle simmer, so as to heat the interior to 158°, will coagulate the albumen, enveloping the fibres and also the coloring matter of the blood, without hardening the flesh. The nutriment and flavor of the meat are thus preserved unimpaired.

According to Liebig, the brine running from meat packed with dry salts, consists mainly of the juice, and that, therefore, the process of salting lessens its nutritious power.

Testing Butter for Casein.—Add ether to the butter, contained in a flask, and shake them together for some time. The butter is dissolved and the cassein remains. (Archiv. der Pharm. lvi.)

3. *Preservation of Food.*—This subject has also been but superficially investigated by the chemist. Some of the substances used for preserving food are ice, sugar, alcohol, and vinegar; but more attention should be given to the preservation of food, by procuring it in a dry state, where chemical action cannot take place. We offer the preservation of milk as an example.

Ice.—As this article is now regarded as almost indispensable to health in summer, and as it is unquestionably one of the greatest luxuries, it would be desirable to manufacture it in the season when it is wanted, especially in latitudes and localities where it is not obtained in sufficient quantity in winter and cannot be procured at a moderate cost by importation. Several of the freezing mixtures, formerly used as subjects of pleasing experiment by the chemist, begin to attract attention, as means of economic manufacture of ice in summer. See an article on the subject, in Amer. Journ. 2d ser. vii. 280.

Preservation of Milk.—Louis (Ch. Gaz. vii. 48) renders milk portable without impairing its original sweetness, by mixing it with clarified sugar, 4 oz. to the gallon, evaporating it in shallow pans by steam, and removing it at the solidifying point, and pressing it into cakes.

Another method recommended is to curdle the sweetened milk by rennet, and then to separate the solid from the liquid portion, by means of a sieve. The whey is evaporated to dryness and the residue mixed, by the aid of heat and a little bicarbonate of soda (1 pt. to 20 pts. of residue), with the curd previously washed and pressed. When the amalgamation is perfect, sufficient tragacanth is added to promote the solidification of the mass.

Milk and Cream.—Bethel has obtained a patent (Newton's Journal, 1849) for preserving milk or cream, by first scalding it, and then surcharging it with carbonic acid by means of

a force-pump, and afterwards drawing it off into strong metal barrels. By the aid of a valve-cock attached to a pipe leading to the bottom, the exit of the liquid, as may be wanted, can be managed; the internal pressure of the gas being sufficient to force out the milk. The milk may be placed in the barrels first and the gas forced in afterwards.

Products of the Decomposition of Casein.—Iljenko (Liebig's Annalen, lxiii.) has reported the following results of the action of water upon casein. He obtained pure casein by washing fresh cheese with water, dissolving it in soda-lye, skimming off the fat which rose to the surface after repose, precipitating casein from the clear liquid by sulphuric acid, and washing with alcohol and ether.

Eight pounds of this casein were mixed with distilled water and exposed to the air at summer heat. After a week, ammoniacal and sulphuretted odors were evolved and continued during the whole process, the liquid remaining alkaline from the commencement to the end of the reaction. The liquid was replaced every four days by fresh water. After ten weeks, the united liquors, after having been tested separately and found to behave alike, were filtered. The casein had decreased in weight considerably during this time.

The volatile products of the distillation of this filtrate were volatile oil, butyric, and valerianic acids. The ammonia generated during the putrefactive fermentation, dissolved a portion of the casein. The liquor also contained *aposepedin*, or oxide of caseum.

VIII. BIOTECHNICS.

Since plants are modified in appearance and special products by the use of manures, and the products of animals are influenced by food and other conditions, the study of these modifying circumstances is an art of the highest importance. To ascertain them to a limited extent, empirical experiment will be of much assistance; but to determine them more fully, proximate analysis of organized bodies and organic mixtures demands a more thorough elaboration. Quantitative proximate analysis is still in its beginning. After this, or simultaneous with its development, must be a study of the successive changes experienced by special substances in plants and animals during growth, both in normal and abnormal conditions, under usual circumstances or when subjected to particular chemical influences. We have an ingenious investigation of this kind to report by Fremy.

1. *Physiology.—Ripening of Fruit.*—Fremy's investigation of the ripening of fruits has opened a new and interesting field. He calls *pectose* a substance associated with cellulose in unripe fruits, in carrots, turnips, &c.; it is insoluble in water, alcohol, and ether. It is converted into *pectin* by heat and dilute acids, or by the ripening of fruits, in which case malic and citric acids produce the effect. When pectin is boiled for some time in water, it is converted into *parapectin*, of the same composition as pectin, but precipitable by sugar of lead. Parapectin boiled with dilute acids is rapidly changed to *metapectin*, of the same composition as pectin, but decidedly acid, and precipitable by chloride of barium. Fremy has found a ferment in fruits, and carrots, &c., which he terms *pectas*, the soluble modification of which is obtained from carrots. Pectas, or cold dilute alkaline solutions, transforms pectin into *pectosic acid.* The longer action of pectas, or alkalies, or ebullition

converts pectin into *pectic acid*, which is insoluble in cold water. Continued ebullition of pectic acid in water converts it into soluble *parapectic acid*, and this is easily changed by dilute acids into *metapectic acid*. The last acid is also formed by the action of strong acids on pectin, or of an excess of alkali on pectin, pectosic or pectic acid. The following table shows the composition of these bodies and their respective compounds with oxide of lead.

			Lead-salt.
Pectose..........	——	......	——
Pectin............	$8HO,C_{64}H_{40}O_{56}$	......	——
Parapectin......	$8HO,C_{64}H_{40}O_{56}$	......	$7HO, PbO,C_{64}H_{40}O_{56}$
Metapectin......	$8HO,C_{64}H_{40}O_{56}$	......	$6HO, 2PbO,C_{64}H_{40}O_{56}$
Pectosic acid....	$3HO,C_{32}H_{20}O_{28}$	......	$HO, 2PbO,C_{32}H_{20}O_{28}$
Pectic acid......	$2HO,C_{32}H_{20}O_{28}$	......	$2PbO,C_{32}H_{20}O_{28}$
Parapectic acid	$2HO,C_{24}H_{15}O_{21}$	......	$2PbO,C_{24}H_{15}O_{21}$
Metapectic acid	$2HO,C_8H_5O_7$	......	$2PbO,C_8H_5O_7$

The above series commences with neutral pectin, and passes through a series of bodies successively more acid, to a strong acid, the metapectic. They either differ from each other by the elements of water, or are isomeric.

The changes of the pectin series by water, acids and alkalies are similar to those which take place in the ripening of fruits. Unripe fruits contain pectose, which is, during ripening, gradually converted into pectin and parapectin, by the action of acids present (malic, &c.); and these are changed by pectas into metapectic acid, which unites with potassa or lime. The metapectic acid probably causes the conversion of starch into sugar. Boiling unripe fruits induces a similar formation of pectin, which by the action of pectas is transformed into gelatinous pectosic and pectic acids, forming a jelly. (Ann. d. Ch. u. Pharm. lxvii.)

2. *The Atmosphere.*—The presence of carbonic acid in the air has long been known. Its influence on vegetation has been brought out more prominently by Liebig. Many experiments seem to determine the presence of ammonia in the air,

and its influence on the growth of plants is maintained by Liebig. Future analysis may determine the presence and influence of other matters, which at present elude our analytic methods, or whose presence is only suspected.

Marchand found, as the mean of 150 experiments, that 10,000 volumes of air contain 3.1 of carbonic acid. Kemp found that 24,840 cubic inches of air yielded 1.8 milligrammes of ammonia. Græger and Horsford have also found ammonia.

The discrepancies in the experiments of Græger, which gave 0.323 grm. ammonia = 0.938 carbonate, and those of Dr. Kemp, determining 3.68 caustic = 10.37 carbonate of ammonia in 1,000,000 grm. of the atmosphere, induced Fresenius to make some essays with a view to the correct decision of the matter. His apparatus consisted of two gasometers, of nearly 2 galls. capacity each, with a collecting apparatus of two flasks, containing 1 pt. muriatic acid of 1.12 and 20 pts. water. The passage of the air was continued, day and night without intermission, for six weeks. The results obtained were .089 ammonia = .283 carbonate during the day, and .169 ammonia = .474 carbonate during the night, in every 1,000,000 grm.

3. *Mineral Manures.*—That mineral matters in the soil exert an important influence on plants is generally admitted, but which substances are most influential and how far they are beneficial have not been determined. On this head, we call attention to the investigations of G. Magnus, of Berlin.

Magnus made a series of careful experiments, during 1849, on the growth of plants (barley having been selected), from which he drew the following conclusions:

1. When mineral matters are not present, the barley attains only the height of 5 inches, and then dies.

2. When a small quantity of mineral matter (different salts) is present, perfect development takes place.

3. If somewhat more mineral matter is present, the plant either grows in a stunted form or is not developed at all.

4. In feldspar alone, barley attains complete development and produces seeds.

5. The progress of growth varies according as the feldspar is used in the state of coarse or fine powder.

6. Manure exerts its fertilizing action also at a distance. It then acts, not only by conveying certain mineral matters to the soil, but its organic constituents also contribute, and that essentially, to the promotion of vegetation.

For a more detailed account of Magnus's experiments, see Chem. Gaz. viii. 261.

Common Salt.—The injurious effects of common salt on vegetation were clearly shown in a case reported to the British Association. See Amer. Journ. 2d ser. vii. 299.

W. B. Randall (Ch. Gaz. vi.) has proved by experiment that water, containing as much as seven grains of chloride of sodium to the pint, is highly destructive to the weaker forms of vegetation.

On the other hand, Dubreuil, Fauchet, and Girardin experimented practically on the effects of common salt on wheat, and found that in the ratio of 6–8½℔ per acre, the straw and grain were both heavier; when more salt was employed, the straw was more influenced than the grain.

Persoz found that hortensias flourished far more in an ordinary soil manured, than the same not manured; the manure being 6℔ boneblack, 3℔ nitric acid, and 1℔ phosphate of potassa. A vine manured with 1℔ silicate of potassa, 3℔ phosphate of potassa and lime, and an equal weight of dried blood and goose-dung, produced a shoot of more than 11 yds. in a year, while another, not manured, gave a shoot of only 4¾ yds.; the former produced on nine shoots 25 bunches of grapes, the latter none.

Polstorff (Ann. Ch. Pharm. lxii. 192) drew the following conclusions from experiments with salts upon barley grown in lead-lined boxes, and in the field: 1. That barley reaches its full development in a soil containing only the constituents of its ashes; 2. That the amount of nitrogen in grain is therefore not dependent on the soil; 3. That mineral manures are capable of producing entirely different results, according to the

form in which their constituents are employed. Excrements gave much more than their ash, when each were employed separately. In the field, he found that ammonia-phosphate of magnesia did not affect the development of the grain, that it injured the formation of the straw, and that mineral manures without ammonia retarded vegetation.

Disintegration of Rocks.—Soils being formed by the disintegration of rocks, the study of this point is of some importance in vegetable physiology.

Ebelmen (Comptes Rendus, xxvi. and Ch. Gaz. vi.) gives, as conclusions from a series of analyses, 1. That silicates, which contain no alumina, lose, on disintegration, silica, lime, and magnesia: sometimes the iron disappears with the bases, and at others, remains in the residue as peroxide. 2. Silicates containing alumina and an alkali, and even other bases also, become richer in alumina on disintegration; and this alumina retains the silicic acid and assimilates water, while the other bases, with a portion of the silicic acid, disappear. In this case, the residue approaches in composition to a hydrated silicate of alumina.

W. B. and R. E. Rogers have given the results of a series of experiments (Amer. Journ. 1848) upon the solvent power of pure and carbonated water upon mineral compounds, by which they prove in two ways, 1st, by an extemporaneous method with the tache, and, 2dly, by prolonged digestion at the ordinary temperature, "the solvent and decomposing power of pure and carbonated water upon all the important mineral aggregates, as well without as with alkaline ingredients."

Phosphate of Lime in Basaltic Rocks.—Deck (Chem. Gaz. vi.) has, by recent analyses of some basalts, proved the presence of phosphate of lime in igneous rock, and thereby confirmed those of Mr. Forbes, in contradiction of those by Prof. Kersten.

Artificial Mineral Manures.—Liebig gives the following proportions of salts, as the basis for manures. 1. $2\frac{1}{2}$ pts. carbonate of lime and 1 pt. potash (or 1 pt. of a mixture of

potash and soda). The potash usually contains 60 per cent. carbonate, 10 per cent. sulphate, 10 muriate, and some silicate of potassa. 2. Equal parts of phosphate of lime, potash, and soda. The above mixtures are each fused separately in a reverberatory. According to the peculiar wants of the soil, the proportions given may be varied, and also different substances added, such as plaster, bones, silicated alkali, ammonia, phosphate of magnesia. According to Stenhouse, the calcareous phosphate may be obtained from urine, as well as from guano and bones, by adding milk of lime, drawing off the liquid from the deposit, and drying the latter. 100lb urine yield nearly ½lb of the precipitate, which when dry contains ⅗ phosphoric acid, ⅖ lime, &c., and ⅐ nitrogenous organic matter.

Analysis of Bone-earth.—Heintz's analyses of bones (Berlin. Berichte, 1849) give the following results.

	Human.		*Sheep.*	*Ox.*
Lime	37.89	37.51	40.00	37.46
Magnesia	0.57	0.56	0.74	0.97
Phosphoric acid	28.27	28.00	29.64	27.89
Carbonic "	2.80	2.81	3.08	3.10
Water, fluorine, and organic matter	30.47	31.12	26.54	30.58

Phosphates of Lime.—Rœsky's experiments (Comptes Rendus, xxvi. and Ch. Gaz. vi.) show that the artificial or bone phosphate of lime has the composition $3CaO,PO_5$; that the biphosphate of lime is decomposed by alcohol into a phosphate and free acid; but the former is not a neutral salt but a new phosphate $3CaO,2PO_5,4HO$.

Solubility of Phosphates.—According to Liebig, 1 litre of water saturated with carbonic acid, dissolves 0.6626 grm. of bone-earth, of which 0.500 grm. is deposited by boiling. (Ann. der Chem. und Pharm. lxi.) According to Lassaigne, water with its own volume of carbonic acid, dissolves in the course of 12 hours, at the temperature of 50°, 0.00075 of artificial basic phosphate of lime, 0.000166 from fresh bones, and 0.0003 from bones that had been buried for 20 years. He

states that 40 cub. centimeters water, containing $\frac{1}{12}$ their weight of common salt, dissolve 0.0127 grm. basic phosphate of lime; and that salammoniac increases the solubility still further. (Journ. Ch. Med. iii. and iv., Comptes Rendus, and Lond. Journ. 1849.) Crum has observed that 100 pts. of various acids (diluted in the proportion of 1 equiv. acid to 1000 eq. water), dissolve from $\frac{3}{4}$ to $1\frac{1}{3}$ pts. of basic phosphate of lime. The acids were sulphuric, tartaric, acetic, lactic, malic, hydrochloric, and nitric; the first dissolving the most, the last, the least. (Ann. der Ch. und Pharm.)

Acid Phosphate of Lime.—It is some years since this salt was proposed as a manure, and repeated trials since that time have fully demonstrated its efficiency. The simplest method of preparing it is as follows. Bones are thrown into heaps, where they soften by fermentation. They are then covered with half their weight of water in wood or stone vats, and half their weight of oil of vitriol added. The whole passes into a pasty state in the course of 8 or 10 days, when it is mixed with earth, charcoal, or sawdust, to render it pulverulent. If it be required to apply the salt in a fluid state to land, the paste is diluted with 100–200 times its bulk of water.

Ammonia Phosphate of Magnesia.—Boussingault and Smith propose making this salt from urine, by treating the latter with a solution of sulphate or muriate of magnesia. The ammonia phosphate will separate in the course of a month. They state that 6300 pts. urine gave 46 pts. of the salt, equal to $\frac{3}{4}$ of one per cent. It might readily be made in towns and manufacturing establishments; and while the proposed treatment will diminish the disagreeable odor of putrefying urine, it will offer an invaluable manure to the agriculturist.

Phosphatometry.—Moride and Bobierre have proposed (Technologiste, 1849) an expeditious method for determining the proportion of phosphates in manures. 1 grm. boneblack or dust, dried at 212°, is to be incinerated and reweighed, so as to estimate the carbon and organic matter by loss. The soluble saline matters are separated from the ash by leeching

with water, and their amount ascertained by the decrease of weight. The residue, insoluble in water, is then carefully digested in nitric acid, saturated dropwise with aqua ammonia, and when a cloudiness appears, treated with acetic acid to redissolve the suspended phosphate of lime.

A normal liquor is now prepared by dissolving 3.107 grm. of pure acetate of lead in 50 cub. centimeters of water, that amount of salt having been found by experiment to be equivalent to 1 grm. phosphate of lime. The liquor must be slightly acidulated with acetic acid, and then poured into a tall glass cylinder graduated into 100 equal parts, so that each degree may represent 1 centigramme of phosphate.

The acetic solution of phosphate, prepared as above, is mixed with this liquid until it assumes a yellowish tint, when two-thirds of its volume of alcohol must be added to mitigate the solvent power of the free acid upon the lead phosphate, and the pouring of the test-liquor continued, very carefully, until a drop of the mixture gives the greenish-yellow lead reaction with iodide of potassium. The number of divisions of the normal liquid required to bring it to this point denotes the number of centigrammes of phosphate of lime contained in the solution.

4. *Organic Manures.*—The fæces of animals alone, or mixed with other organic matter which they cause to putrefy, have been used as manures time out of mind, and their value universally attested. The great influence of their ashes or mineral constituents has been investigated latterly, and has almost led to a disregard of their organic contents, unless in the form of a compound yielding up ammonia to the air. Too much haste has been shown in these conclusions. We report a few examinations of excrements, which are of value independently of theory.

Human Fæces.—Fleitmann, who carefully examined the human fæces (Silliman's Journ. 1849), found their inorganic contents, as follows:

	Fæces of one Day.	*Urine of one Day.*
NaCl	0.0167	8.9243
NaO	0.0185	—
KCl	—	0.7511
KO	0.5455	2.4823
CaO	0.5566	0.2245
MgO	0.2781	0.2415
Fe_2O_3	0.0544	0.0048
PO_5	0.8072	1.7598
SO_3	0.0293	0.3864
SiO_3	0.0375	0.0691
	2.3438	14.8438

Composition of Excrements.—The first four analyses are by J. R. Rogers (Ann. Ch. Pharm. lxv. 85), the fifth is by Vohl.

CONSTITUENTS.	Pig.	Cow.	Sheep.	Horse.	Dog.
100 of flesh excrement yielded water.	77.13	82.45	56.47	77.25	....
" dried " at 212° yielded ash.	37.17	15.23	13.49	13.36	....
" ash gave matters soluble in water	9.65	5.84	17.29	3.16	....
" ash gave matters soluble in hydrochloric acid	18.70	32.21	....	22.59	....
" ash gave matters soluble in nitric acid	....	....	34.54	....	....
" ash gave insoluble residue	71.65	61.95	48.17	74.25	....
Composition of the Ash.					
Potassa	3.60	2.91	8.32	11.30	0.30
Soda	3.44	0.98	3.28	1.98	0.44
Lime	2.03	5.71	18.15	4.63	33.05
Magnesia	2.24	11.47	5.45	3.84	0.09
Oxides of manganese	....	....	traces.	2.13	....
Chloride of sodium	0.89	0.23	0.14	0.03	....
Phosphate of iron	10.55	8.93	3.98	2.73	....
Phosphoric acid	0.41	4.76	7.52	8.93	34.46
Sulphuric "	0.90	1.77	2.69	1.83	....
Carbonic "	0.60	....	traces.	....	7.46
Chlorine "	....	....	....	....	0.04
Silica	13.19	62.54	50.11	62.40	traces.
Sand	61.37				....
Iron	....	....	....	....	0.01
Organic matter	....	....	....	....	14.15

Kuhlmann has concluded from his experiments that, while salts exert an influence in promoting the growth of plants, nitrogenous matter is the most efficacious.

Deodorizing Putrid Matter.—Among the various substances proposed to disinfect excrements, and at the same time to fix and retain their valuable constituents, some, as sulphuric and muriatic acids, expel sulphuretted hydrogen, and are therefore objectionable; others, as the metallic salts, may themselves be injurious to plants (see Magnus's experiments). Boussingault proposed chloride of magnesium, which would form the difficultly soluble ammonia-phosphate of magnesia. Calloud proposes the mother-waters of salines, containing salts of lime and magnesia, together with charcoal. While the former would form phosphates of slow solubility, the coal absorbs the noxious gases, and by its porosity also oxidizes sulphuret of ammonium into sulphate of ammonia.

To deodorize human excrements, the best material is probably the pyrolignate of iron, the free acid of which has been previously neutralized by a base (ashes, lime, &c.).

To prevent the escape of disagreeable and perhaps noxious gases from decomposing animal matter, and to convert it into good manure, E. Brown recommends (Lond. Journ. Arts, 1847) pouring into a privy a dilute solution of sulphate, muriate, or pyrolignate of iron, or muriate of manganese (from the manufacture of bleaching-salt), stirring up, then covering it with a good absorbent (75 pts. wood-ash, and 25 pts. sawdust, bone-powder, &c.), and closing the building for 10 minutes. Thus freed from odor, it may be transported to a poudrette building, where it is mixed with 15–20 per cent. of a drying powder, dried, and packed.

Blood may be rendered inodorous and incapable of putrefaction by adding to it a solution of chloride of iron or of manganese, which unites with and coagulates the albuminous matter, and then drying it alone, or mixing with absorbents and drying it.

5. *Ashes of Plants.*—It is hoped, and with good reason, that an accurate determination of the ashes of plants and of parts of plants, will assist in determining what special mineral substances are needed by those plants, or their parts, for their more perfect development. Hence these analyses have been

multiplied in no ordinary degree within the few last years. For the fullest view of them, we refer to the Annual Report for 1849, by Liebig, Kopp and others, and give here only an example of such analyses.

Ashes of Pine-wood.—Sacc's analysis (Ann. de Chim. et de Phys. xxv.) gives the following result:

Silica	10.8667
Sulphuric acid	1.2844
Phosphoric acid	3.5569
Chlorine	0.1229
Peroxide of iron	2.6018
Protoxide of manganese	2.6498
Magnesia	3.9873
Lime	58.6475
Potassa	2.3076
Soda	13.9751

Ashes of Coffee.—T. J. Herapath, who analyzed the ashes of the berries of the *coffea Arabica*, with a view to the determination of the best manure for promoting the growth of the plant, obtained the following per centage composition. (Ch. Gaz. vi.)

Phosphoric acid	19.801
Sulphuric "	0.244
Potassa	16.512
Soda	6.787
Chloride of sodium	0.645
Lime	2.329
Magnesia	5.942
Sulphate of lime	1.751
Phosphate of lime	45.551
Silicic acid	0.438
	100.000

The author calculates, from this analysis, that every ton of berries removes from the soil the following proportions of mineral substances:

	lbs.	oz.
Phosphoric acid	27	14½
Sulphuric "	0	13½
Potassa	11	4
Soda	4	10
Chloride of sodium	0	7
Lime	18	14
Magnesia	4	1
Silicic acid	0	5
	68	5

6. *Agricultural Products.*—That chemistry might prove a great benefit to agriculture, no one doubts; but that it has not yet done so, is true. The changes undergone by milk and cream in their metamorphosis into cheese and butter have not been minutely and accurately studied; and by way of illustrating the bearing of chemistry on these points, we offer an alkalimetric method of determining the richness of milk, and Reiset's examination of the yield of butter under different circumstances of milking.

Lactometry.—Poggiale (Comptes Rendus, 1849) proposes to estimate the richness of milk by determining the volume of sugar of milk contained in it; the proportion of that ingredient having been found by experiment to be uniformly near 52.7 in 1000 pts. of pure milk. His process is based upon the reduction of copper-salt by sugar of milk. He employs a test-liquid, made by mixing a solution of 10 grm. crystallized sulphate of copper, with one of 10 grm. crystallized bitartrate of potassa, and dissolving the precipitate in an aqueous solution of 30 grm. caustic potassa, diluting with water to the quantity of 200 grm., and filtering. 20 cubic centimeters of this clear blue liquid correspond with two decigrammes of whey, of which latter pure milk contains 923 pts. in the thousand. In 1000 pts. of whey, there are therefore 57 pts. of sugar. The fat and casein having been coagulated by mixing the milk, say 50 grm. with a few drops of acetic acid, and heating to 120°, are then to be separated

by filtration. The filtrate or whey is poured into a cylinder graduated into divisions of a fifth of a cubic centimeter, and thence added, dropwise, to 20 cub. centimeters of the test-liquid, until the disappearance of its blue color. The number of divisions of whey required to effect this are then to be noted, and the weight of sugar in the 1000 pts. calculated by the rule of three. The liquor must be contained in a glass flask and boiled before and after each addition of whey.

Yield of Butter.—Reiset instituted a series of experiments to determine the truth of a statement by Peligot, that, during milking, the last portions of milk were richer in solid constituents than the first. He employed two cows, which grazed through the day and were stalled without food through the night. The following tables contain the results. The residues were obtained by evaporating 20 grm. of the milk to dryness at 212°.

White Cow, No. 1.						
DATE.	Time of Milking.	Time since the previous Milking	Residue in 100 pts. of the first Milk.	Residue in 100 pts. of the last Milk.	Mean.	Weight of Milk obtained.
1843.	h. min.	h. min.				
16 Oct.	6 A. M.	12	9.33	16.04	12.68	4940
27 "	7 "	12	9.90	15.85	12.87	4840
31 "	7 "	12	9.90	17.82	13.86	4200
29 "	6 30 P. M.	11 30	10.41	21.30	15.85	4570
31 "	6 30 "	11 30	9.62	19.07	14.34	4100
28 "	6 30 "	6	13.30	16.30	14.80	2000
26 "	6 30 "	6	12.80	16.06	14.43	2540
25 "	12 M.	5	11.49	17.70	14.60	2600
27 "	12 "	5	12.00	21.20	16.60	2695
1 Nov.	12 "	5	13.60	18.50	16.05	2355
30 Oct.	4 P. M.	4	17.19	16.93	17.06	1320
1 Nov.	4 "	4	15.28	14.73	15.00	1240
30 Oct.	6 30 "	6 30	14.60	13.33	13.86	425
1 Nov.	6 30 "	6 30	12.84	13.08	12.86	530
1844.						
20 Sept.	2 15 "	1 15	13.65	13.89	13.77	650
"	3 30 "	1 15	11.65	11.89	11.77	60
"	5 "	1 30	10.96	—	—	20
"	6 30 "	1 30	10.88	13.33	12.10	normal.
1843.		*Red Cow, No. 2.*				
3 Nov.	7 A. M.	12 30	11.01	17.63	14.32	4465
2 "	6 30 P. M.	6 30	13.15	17.29	15.22	2210
3 "	12 M.	5	14.37	18.93	16.65	2120
"	6 30 P. M.	5	13.20	17.50	15.35	2040
"	1 30 "	1 30	18.34	16.33	17.33	80
1844.				Residue of the middle.	Residue of last milk.	
20 Sept.	12 M.	5	10.96	13.14	19.20	White Cow.
27 "	"	5	12.13	13.72	20.00	Red Cow.

The white cow gave, on an average, in 24 hours, 12,500 grm. milk; the red cow, 10,250 grm. Both cows were usually milked at 6 A. M., 12 M., and 6 P. M. It appears from the above, that the fat on the milk behaves in the udder as in any quiet vessel, for the last portions are generally richer than the first. But this only occurs when it remains more than 4 hours; for if it be drawn off every 2 hours, it is uniform. The milk obtained from cows which are kept on the grass, is decidedly richer than that obtained from such as are stalled at night without feed.

The differences observed above in the milk seem only to affect the fat; for that portion of the residue insoluble in ether, as well as the nitrogen and ashes of this portion, are almost constant, as shown by the following table. The numbers in the first column will be found in the preceding table, the first of each pair being the residue from the first portions milked, the second from the last, with their respective quantities soluble in ether (fat, &c.), and insoluble (casein, &c.).

Residue in 100 pts. Milk.	Soluble in Ether.	Insoluble in Ether.	Nitrogen in 100 pts. of that insoluble in Ether.	Salts in 100 pts. of the same Residue.
9.90	1.80	8.10	...	...
15.86	6.60	9.25	...	...
9.90	0.80	9.10	...	...
17.82	9.60	8.22	...	...
10.41	1.07	9.34	6.36	0.71
21.30	13.20	8.10	6.28	0.80
12.00	3.30	8.70	5.88	0.75
21.20	13.10	8.10	6.09	0.84
13.60	5.23	8.37	...	...
18.50	10.70	7.80	...	...
17.19	9.70	7.49	...	...
16.93	8.60	8.33	6.69	1.11
11.01	2.20	8.81	5.32	...
17.63	9.70	7.93	6.26	0.74
13.20	4.40	8.80	6.42	0.63
17.50	9.10	8.40	5.70	0.70
13.15	4.30	8.85	5.96	...
17.29	8.80	8.49	...	...
14.60	7.20	7.40	...	...
13.33	7.10	6.23	...	...
15.28	4.90	10.38	...	...
14.73	5.10	9.63	...	...
12.84	4.90	7.94	...	...
13.08	4.30	8.78	...	...
9.62	1.22	8.40	6.34	0.75
19.07	11.20	7.87	6.11	0.74
14.37	5.90	8.47	5.92	0.77
18.93	10.50	8.43	6.00	0.77

It appears from the foregoing that it would be better for the farmer to reserve the last portions of milk for making butter, in order to obtain a larger yield from the same weight of milk; unless, indeed, all the milk obtained is employed for this purpose. The following experiments show this conclusively.

1. From the 21st to 28th Aug. 1843, 106,056 grm. of milk gave 4850 grm. butter, or 4.57 per cent. of the milk.
2. From the 6th to the 10th Sept., 62,415 grm. milk gave 2870 grm. butter, or $4\frac{1}{2}$ per cent.

3. Milk collected from 27th Sept. to 3d Oct......	79,025	grm.
Last portions of the milking, worked for butter..	18,765	"
Amount of butter obtained......................	1,245	"
Or 6.63 per cent. of the milk employed.		
4. Milk obtained from 4th to 7th Oct............	42,835	"
Last portions of the milkings....................	8,565	"
Butter obtained..	721	"
Or 7.53 per cent. of the milk used.		
5. Milk obtained from 8th to 15th Oct. (inclusive)	85,850	"
Last portions of the milkings....................	12,495	"
Butter obtained..	1,050	"
Or 8.4 per cent. of the milk used.		

(Ann. de Chim. et de Phys. (3) xxv. 82–85. Abstr. in Ch. u. Ph. Centralbl. 1850.)

INDEX.

THE END.

STEREOTYPED BY L. JOHNSON AND CO.
PHILADELPHIA.

EXTRACTS

FROM THE

PROCEEDINGS OF THE BOARD OF REGENTS

OF THE

SMITHSONIAN INSTITUTION,

IN RELATION TO

THE ELECTRO-MAGNETIC TELEGRAPH.

EXTRACTS

FROM THE

PROCEEDINGS OF THE BOARD OF REGENTS

OF THE

SMITHSONIAN INSTITUTION.

WASHINGTON, *March* 16, 1857.

The Secretary, Prof. Jos. HENRY, made a communication to the Board, [A,] relative to an article which had been published by Prof. S. F. B. MORSE, containing charges against his moral character and his scientific reputation.

The Chancellor, Chief Justice TANEY, corroborated Prof. HENRY'S statement as to his advising a delay in noticing the publication referred to, until the public mind should be more settled in regard to the policy of the Institution, and the discussions which had arisen in Congress in reference to it should be ended.

He stated that it would be seen by the report of the decision of the Supreme Court, in the case in which Professor Henry was a witness, that, in the opinion of the court, Prof. Morse had produced no testimony that could invalidate the testimony of Professor Henry, or impair in any degree its weight; and that the court gave full credit to it in the judgment it pronounced.

On motion of Mr. MASON, the following resolution was adopted:

Resolved, That the communication of the Secretary and accompanying documents be referred to a committee, to examine and report upon it at the next session of the Board of Regents.

Whereupon the Chancellor appointed Messrs. Mason, Pearce, Felton, and Douglas as the committee.

Washington, *May* 19, 1858.

Prof. Felton, in behalf of the special committee to whom the communication of Professor Henry, of March 16, 1857, together with accompanying documents, &c., were referred, presented a report, [B.] * * *

The report was accepted, and the resolutions submitted [C] were unanimously adopted.

[A.]

COMMUNICATION

FROM

PROF. JOSEPH HENRY, SECRETARY OF THE SMITHSONIAN INSTITUTION

RELATIVE TO A

PUBLICATION BY S. F. B. MORSE.

Presented to the Board of Regents of the Smithsonian Institution, March 16, 1857.

GENTLEMEN: In the discharge of the important and responsible duties which devolve upon me as Secretary of the Smithsonian Institution, I have found myself exposed, like other men in public positions, to unprovoked attack and injurious misrepresentation. Many instances of this, it may be remembered, occurred about two years ago, during the discussions relative to the organic policy of the Institution; but, though very unjust, they were suffered to pass unnoticed, and generally made, I presume, no lasting impression on the public mind.

During the same controversy, however, there was one attack made upon me of such a nature, so elaborately prepared and widely circulated, by my opponents, that, though I have not yet publicly noticed it, I have, from the first, thought it my duty not to allow it to go unanswered. I allude to an article in a periodical entitled "Shaffner's Telegraph Companion," from the pen of Prof. S. F. B. Morse, the celebrated inventor of the American electro-magnetic telegraph. In this, not my scientific reputation merely, but my moral character was pointedly assailed; indeed, nothing less was attempted than to prove that in the testimony which I had given in a case where I was at most but a reluctant witness, I had consciously and wilfully deviated from the truth, and this, too, from unworthy and dishonorable motives.

Such a charge, coming from such a quarter, appeared to me then, as it appears now, of too grave a character and too serious a consequence to be withheld from the notice of the Board of Regents. I, therefore, presented the matter unofficially to the Chancellor of the Institution, Chief Justice Taney, and was advised by him to allow the matter to rest until the then existing excitement with respect to the organization of the Institution

should subside, and that in the meantime the materials for a refutation of the charge might be collected and prepared, to be brought forward at the proper time, if I should think it necessary.

The article of Mr. Morse was published in 1855, but at the session of the Board in 1856 I was not prepared to present the case properly to your consideration, and I now (1857) embrace the first opportunity of bringing the subject officially to your notice, and asking from you an investigation into the justice of the charges alleged against me. And this I do most earnestly, with the desire that when we shall all have passed from this stage of being, no imputation of having attempted to evade in silence so grave a charge shall rest on *me;* nor on *you*, of having continued to devolve upon me duties of the highest responsibility, after that was known to some of you individually, which, if true, should render me entirely unworthy of your confidence. Duty to the Board of Regents, as well as regard to my own memory, to my family, and to the truth of history, demands that I should lay this matter before you, and place in your hands the documents necessary to establish the veracity of my testimony, so falsely impeached, and the integrity of my motives, so wantonly assailed.

My life, as is known to you, has been principally devoted to science, and my investigations in different branches of physics have given me some reputation in the line of original discovery. I have sought, however, no patent for inventions, and solicited no remuneration for my labors, but have freely given their results to the world, expecting only, in return, to enjoy the consciousness of having added, by my investigations, to the sum of human knowledge, and to receive the credit to which they might justly entitle me.

I commenced my scientific career about the year 1828, with a series of experiments in electricity, which were continued at intervals up to the period of my being honored by election to the office of Secretary of this Institution. The object of my researches was the advancement of science, without any special or immediate reference to its application to the wants of life or useful purposes in the arts. It is true, nevertheless, that some of my earlier investigations had an important bearing on the electro-magnetic telegraph, and brought the science to that point of development at which it was immediately applicable to Mr. Morse's particular invention.

In 1831 I published a brief account of these researches, in which I drew attention to the fact of their applicability to the telegraph; and in 1832, and subsequently, exhibited experiments illustrative of the application of the electro-magnet to the transmission of power to a distance, for producing telegraphic and other effects. The results I had published

were communicated to Mr. Morse, by his scientific assistant, Dr. Gale, as will be shown on the evidence of the latter; and the facts which I had discovered were promptly applied in rendering effective the operation of his machine.

In the latter part of 1837 I became personally acquainted with Mr. Morse, and at that time, and afterwards, freely gave him information in regard to the scientific principles which had been the subject of my investigations. After his return from Europe, in 1839, our intercourse was renewed, and continued uninterrupted till 1845. In that year, Mr. Vail, a partner and assistant of Mr. Morse, published a work purporting to be a history of the Telegraph, in which I conceived manifest injustice was done me. I complained of this to a mutual friend, and subsequently received an assurance from Mr. Morse that if another edition were published, all just ground of complaint should be removed. A new emission of the work, however, shortly afterwards appeared, without change in this respect, or further reference to my labors. Still I made no public complaint, and set up no claims on account of the telegraph. I was content that my published researches should remain as material for the history of science, and be pronounced upon, according to their true value, by the scientific world.

After this, a series of controversies and lawsuits having arisen between rival claimants for telegraphic patents, I was repeatedly appealed to, to act as *expert* and witness in such cases. This I uniformly declined to do, not wishing to be in any manner involved in these litigations, but was finally compelled, under legal process, to return to Boston from Maine, whither I had gone on a visit, and to give evidence on the subject. My testimony was given with the statement that I was not a willing witness, and that I labored under the disadvantage of not having access to my notes and papers, which were in Washington. That testimony, however, I now reaffirm to be true in every essential particular. It was unimpeached before the court, and exercised an influence on the final decision of the question at issue.

I was called upon on that occasion to state, not only what I had published, but what I had done, and what I had shown to others in regard to the telegraph. It was my wish, in every statement, to render Mr. Morse full and scrupulous justice. While I was constrained, therefore, to state that he had made no discoveries in science, I distinctly declared that he was entitled to the merit of combining and applying the discoveries of others, in the invention of the best practical form of the magnetic telegraph. My testimony tended to establish the fact that, though not entitled to the exclusive use of the electro-magnet for telegraphic purposes, he was entitled to his particular machine, register, alphabet, &c. As this, however,

did not meet the full requirements of Mr. Morse's comprehensive claim, I could not but be aware that, while aiming to depose nothing but truth and the whole truth, and while so doing being obliged to speak of my own discoveries, and to allude to the omissions in Mr. Vail's book, I might expose myself to the possible, and, as it has proved, the actual, danger of having my motives misconstrued and my testimony misrepresented. But I can truly aver, in accordance with the statement of the counsel, Mr. Chase, (now Governor of Ohio,) that I had no desire to arrogate to myself undue merit, or to detract from the just claims of Mr. Morse.

I have the honor to be your obedient servant,

JOSEPH HENRY.

To the Board of Regents.

[B.]

REPORT

OF

THE SPECIAL COMMITTEE OF THE BOARD OF REGENTS

ON THE

COMMUNICATION OF PROF. HENRY.

Professor HENRY laid before the Board of Regents of the Smithsonian Institution a communication relative to an article in Shaffner's Telegraph Companion, bearing the signature of SAMUEL F. B. MORSE, the inventor of the American electro-magnetic telegraph. In this article serious charges are brought against Professor Henry, bearing upon his scientific reputation and his moral character. The whole matter having been referred to a committee of the Board, with instructions to report on the same, the committee have attended to the duty assigned to them, and now submit the following brief report, with resolutions accompanying it.

The committee have carefully examined the documents relating to the subject, and especially the article to which the communication of Professor Henry refers. This article occupies over ninety pages, filling an entire number of Shaffner's Journal, and purports to be "a defence against the injurious deductions drawn from the deposition of Professor Joseph Henry, (in the several telegraph suits,) with a critical review of said deposition, and an examination of Professor Henry's alleged discoveries bearing upon the electro-magnetic telegraph."

The first thing which strikes the reader of this article is, that its title is a misnomer. It is simply an assault upon Professor Henry; an attempt to disparage his character; to deprive him of his honors as a scientific discoverer; to impeach his credibility as a witness and his integrity as a man. It is a disingenuous piece of sophistical argument, such as an unscrupulous advocate might employ to pervert the truth, misrepresent the facts, and misinterpret the language in which the facts belonging to the other side of the case are stated.

Mr. Morse charges that the deposition of Professor Henry "contains imputations against his (Morse's) personal character," which it does not,

and assumes it as a duty "to expose the utter non-reliability of Professor Henry's testimony;" that testimony being supported by the most competent authorities, and by the history of scientific discovery. He asserts that he "is not indebted to him (Professor Henry) for any discovery in science bearing on the telegraph," he having himself acknowledged such indebtedness in the most unequivocal manner, and the fact being independently substantiated by the testimony of Sears C. Walker, and the statement of Mr. Morse's own associate, Dr. Gale. Mr. Morse further maintains, that all discoveries bearing upon the telegraph, were made, not by Professor Henry, but by others, and prior to any experiments of Professor Henry in the science of electro-magnetism; contradicting in this proposition the facts in the history of scientific discovery perfectly established and recognized throughout the scientific world.

The essence of the charges against Professor Henry is, that he gave false testimony in his deposition in the telegraph cases, and that he has claimed the credit of discoveries in the sciences bearing upon the electro-magnetic telegraph which were made by previous investigators; in other words, that he has falsely claimed what does not belong to him, but *does* belong to others.

Professor Henry, as a private man, might safely have allowed such charges to pass in silence. But standing in the important position which he occupies, as the chief executive officer of the Smithsonian Institution; and regarding the charges as undoubtedly containing an impeachment of his moral character, as well as of his scientific reputation; and justly sensitive, not only for his own honor, but for the honor of the Institution, he has a right to ask this Board to consider the subject, and to make their conclusions a matter of record, which may be appealed to hereafter should any question arise with regard to his conduct in the premises.

Your committee do not conceive it to be necessary to follow Mr. Morse through all the details of his elaborate attack. Fortunately, a plain statement of a few leading facts will be sufficient to place the essential points of the case in a clear light.

The deposition already referred to was reluctantly given, and under the compulsion of legal process, by Professor Henry, before the Hon. George S. Hillard, United States commissioner, on the 7th of September, 1849.

The following is the statement of the Hon. S. P. Chase, (now Governor of Ohio,) one of the counsel in the telegraph cases, in a letter to Professor Henry, dated Columbus, Ohio, November 26, 1856.

In the year 1849, I was professionally employed in the defence of certain gentlemen engaged in the business of telegraphing between Louisville and New Orleans, against whom a bill of complaint had been filed in the Circuit Court of

the United States for the district of Kentucky. The object of the bill was to restrain the defendants, my clients, from the use in telegraphing of a certain instrument called the Columbian Telegraph, on the ground that it was an infringement upon the rights of the complainants under the patents granted to Professor Morse. It therefore became my duty, in the preparation of their defence, to ascertain the precise nature and extent of their rights. With this view I called upon you, in August or September of that year, for your deposition. It was taken before George S. Hillard, esq., a United States Commissioner for the District of Massachusetts, in Boston. I remember very well that you were unwilling to be involved in the controversy, even as a witness, and that you only submitted to be examined in compliance with the requirements of law. Not one of your statements was volunteered. They were all called out by questions propounded either verbally or in writing I was not sufficiently familiar at the time with the precise merits of the case to know what would or would not be important, and therefore insisted on a full statement, not merely of the general history of electro-magnetism as applied to telegraphing, but of all your own discoveries in that science having relation to the same art, and of all that had passed between yourself and Professor Morse connected with these discoveries or with the telegraph. You could not have refused to respond to the questions propounded, without subjecting yourself to judicial animadversion and constraint. Nothing in what you testified, or your manner of testifying, suggested to me the idea that you were animated by any desire to arrogate undue merit to yourself, or to detract from the just claims of Professor Morse.

S. P. CHASE.

Previous to this deposition, Mr. Morse, as appears from his own letters and statements, entertained for Professor Henry the warmest feelings of personal regard, and the highest esteem for his character as a scientific man. In a letter, dated April 24, 1839, he thanks Prof. Henry for a copy of his "valuable contributions," and says, "I perceive many things (in the contributions) of great interest to me in my telegraphic enterprise." Again, in the same letter, speaking of an intended visit to the Professor at Princeton, he says: "I should come as a learner, and could bring no 'contributions' to your stock of experiments of any value." And still further: "I think that you have pursued an original course of experiments, and discovered facts more immediately bearing upon my invention than any that have been published abroad."

It appears, from Mr. Morse's own statement, that he had at least two interviews with Prof. Henry—one in May, 1839, when he passed the afternoon and night with him, at Princeton; and another in February, 1844—both of them for the purpose of conferring with him on subjects relating to the telegraph, and evidently with the conviction, on Mr. Morse's part, that Prof. Henry's investigations were of great importance to the success of the telegraph.

As late as 1846, after Mr. Morse had learned that some dissatisfaction existed in Prof. Henry's mind in regard to the manner in which his researches in electricity had been passed over by Mr. Vail, an assistant of Mr. Morse, and the author of a history of the American magnetic tele-

graph, Mr. Morse, in an interview with Prof. Henry, at Washington, said, according to his own account, "Well, Prof. Henry, I will take the earliest opportunity that is afforded me in anything I may publish, to have justice done to your labors; for I do not think that justice has been done you, either in Europe or this country."

Again, in 1848, when Prof. Walker, of the Coast Survey, made his report on the theory of Morse's electro-magnetic telegraph, in which the expression occurred, "the helix of a soft iron magnet, prepared after the manner first pointed out by Prof. Henry," Mr. Morse, to whom the report was submitted, said: "I have now the long wished for opportunity to do justice publicly to Henry's discovery bearing on the telegraph." And in a note prepared by him, and intended to be printed with Prof. Walker's report, he says: "The allusion you make to the helix of a soft iron magnet, prepared after the manner first pointed out by Prof. Henry, gives me an opportunity, of which I gladly avail myself, to say that I think that justice has not yet been done to Prof. Henry, either in Europe or in this country, for the discovery of a scientific fact, which, in its bearing on telegraphs, whether of the magnetic needle or electro-magnet order, is of the greatest importance."

He then proceeds to give a historical synopsis, showing that, although suggestions had been made and plans devised by Soemmering, in 1811, and by Ampère, in 1820, yet that the experiments of Barlow, in 1824, had led that investigator to pronounce "the idea of an electric telegraph to be chimerical"—an opinion that was, for the time, acquiesced in by scientific men. He shows that, in the interval between 1824 and 1829, no further suggestions were made on the subject of electric telegraphs. But he proceeds—"In 1830, Prof. Henry, assisted by Dr. Ten Eyck, while engaged in experiments on the application of the principle of the galvanic multiplier to the development of great magnetic power in soft iron, made the important discovery that a battery of intensity overcame that resistance in a long wire which Barlow had announced as an insuperable bar to the construction of electric telegraphs. Thus was opened the way for fresh efforts in devising a practicable electric telegraph; and Baron Schilling, in 1832, and Professors Gauss and Weber, in 1833, had ample opportunity to learn of Henry's discovery, and avail themselves of it, before they constructed their needle telegraphs." And, while claiming for himself that he was "the first to propose the use of the electro-magnet for telegraphic purposes, and the first to construct a telegraph on the basis of the electro-magnet," yet he adds, "*to Professor Henry is unquestionably due the honor of the discovery of a principle which proves the practicability of exciting magnetism through a long coil, or at a distance, either to deflect a needle or to magnetize soft iron.*"

What Mr. Morse here describes as a "principle," the discovery of which is unquestionably due to Professor Henry, is the law which first made it possible to work the telegraphic machine invented by Mr. Morse, and for the knowledge of which Mr. Morse was indebted to Professor Henry, as is positively asserted by his associate, Dr. Gale. This gentleman, in a letter, dated Washington, April 7, 1856, makes the following conclusive statement:

WASHINGTON, D. C., *April* 7, 1856.

SIR: In reply to your note of the 3d instant, respecting the Morse telegraph, asking me to state definitely the condition of the invention when I first saw the apparatus in the winter of 1836, I answer: This apparatus was Morse's original instrument, usually known as the type apparatus, in which the types, set up in a composing stick, were run through a circuit breaker, and in which the battery was the cylinder battery, with a single pair of plates. This arrangement also had another peculiarity, namely, it was the electro-magnet used by Moll, and shown in drawings of the older works on that subject, having only a few turns of wire in the coil which surrounded the poles or arms of the magnet. The sparseness of the wires in the magnet coils and the use of the single cup battery were to me, on the first look at the instrument, obvious marks of defect, and I accordingly suggested to the Professor, without giving my reasons for so doing, that a battery of many pairs should be substituted for that of a single pair, and that the coil on each arm of the magnet should be increased to many hundred turns each; which experiment, if I remember aright, was made on the same day with a battery and wire on hand, furnished I believe by myself, and it was found that while the original arrangement would only send the electric current through a few feet of wire, say 15 to 40, the modified arrangement would send it through as many hundred. Although I gave no reasons at the time to Professor Morse for the suggestions I had proposed in modifying the arrangement of the machine, I did so afterwards, and referred in my explanations to the paper of Professor Henry, in the 19th volume of the American Journal of Science, page 400 and onward. It was to these suggestions of mine that Professor Morse alludes in his testimony before the Circuit Court for the eastern district of Pennsylvania, in the trial of B. B. French and others *vs.* Rogers and others.—See printed copy of Complainant's Evidence, page 168, beginning with the words "Early in 1836 I procured 40 feet of wire," &c., and page 169, where Professor Morse alludes to myself and compensation for services rendered to him, &c.

At the time I gave the suggestions above named, Professsor Morse was not familiar with the then existing state of the science of electro-magnetism. Had he been so, or had he read and appreciated the paper of Henry, the suggestions made by me would naturally have occurred to his mind as they did to my own. But the principal part of Morse's great invention lay in the mechanical adaptation of a power to produce motion, and to increase or relax at will. It was only necessary for him to know that such a power existed for him to adapt mechanism to direct and control it

My suggestions were made to Professor Morse from inferences drawn by reading Professor Henry's paper above alluded to. Professor Morse professed great surprise at the contents of the paper when I showed it to him, but especially at the remarks on Dr. Barlow's results respecting telegraphing, which were new to him, and he stated at the time that he was not aware that any one had even conceived the idea of using the magnet for such purposes.

With sentiments of esteem, I remain, yours truly,

L. D. GALE.

Prof. JOS. HENRY, *Secretary of the Smithsonian Institution.*

It further appears, that principally for the information thus communicated, Mr. Morse assigned to Dr. Gale an interest in the telegraph, which he afterwards purchased back for $15,000, as appears from the following letter of Dr. Gale:

PATENT OFFICE, *August* 5, 1857.

DEAR SIR: In reply to yours of this date, respecting the interest I once possessed in Morse's telegraph patent, secured to me by the said Morse, as alluded to by him in his statement to the Commissioner of Patents, I would simply state that the part I owned when I entered the service of the government in this office was originally given me by the said Morse, for services rendered him in making his invention practically effective in sending currents through long distances, &c., and that the said interest was retransferred to the said Morse for the sum of fifteen thousand dollars.

Respectfully,

L. D. GALE.

Professor HENRY,
Secretary Smithsonian Institution.

It thus appears, both from Mr. Morse's own admission down to 1848, and from the testimony of others most familiar with the facts, that Prof. Henry discovered the law, or "principle," as Mr. Morse designates it, which was necessary to make the practical working of the electro-magnetic telegraph at considerable distances possible; that Mr. Morse was first informed of this discovery by Dr. Gale; that he availed himself of it at once, and that it never occurred to Mr. Morse to deny this fact until after 1848. He had steadily and fully acknowledged the merits and genius of Mr. Henry, as the discoverer of facts and laws in science of the highest importance in the success of his long-cherished invention of a magnetic telegraph. Mr. Henry was the discoverer of a principle, Mr. Morse was the inventor of a machine, the object of which was to record characters at a distance, to convey intelligence, in other words, to carry into execution the idea of an electric telegraph. But there were obstacles in the way which he could not overcome until he learned the discoveries of Professor Henry, and applied them to his machine. These facts are undeniable. They constitute a part of the history of science and invention. They were true in 1848, they were equally true in 1855, when Professor Morse's article was published. We give a passage here from the deposition of SEARS C. WALKER, in the case of French *vs.* Rogers, Respondent's Evidence, page 199, bearing upon this whole subject:

"In consequence of some statements made by me in my official reports relative to the invention of the receiving magnet, a question arose between Mr. Morse and myself as to the origin of this invention. It was amicably discussed by Mr. Morse, Professor Henry, Dr. Gale, and myself, with Professor Henry's article, alluded to in answer to the second question before us. The result of the interview was conclusive to my mind that Professor Henry was the sole discoverer of

the law on which the intensity magnet depends for its power of sending the galvanic current through a long circuit. I was also led to conclude that Mr. Morse, in the course of his own researches and experiments before he had read Professor Henry's article, before alluded to, had encountered the same difficulty Mr. Barlow and those who preceded him had encountered, that is, the impossibility of forcing the galvanic current through a long telegraph line. His own personal researches had not overcome this obstacle. They were made in the laboratory of the New York University. I also learned at the same time, by the conversations above stated, that he only overcame this obstacle by constructing a magnet on the principle invented by Professor Henry, and described in his article in Silliman's Journal. His attention was directed to it by Dr. Gale."

What changed Mr. Morse's opinion of Professor Henry, not only as a scientific investigator, but as a man of integrity, after the admissions of his indebtedness to his researches, and the oft repeated expressions of warm personal regard? It appears that Mr. Morse was involved in a number of lawsuits, growing out of contested claims to the right of using electricity for telegraphic purposes. The circumstances under which Professor Henry, as a well known investigator in this department of physics, was summoned by one of the parties to testify have already been stated. The testimony of Mr. Henry, while supporting the claims of Mr. Morse as the inventor of an admirable invention, denied to him the additional merit of being a discoverer of new facts or laws of nature, and to this extent, perhaps, was considered unfavorable to some part of the claim of Mr. Morse to an *exclusive* right to employ the electro-magnet for telegraphic purposes. Professor Henry's deposition consists of a series of answers to verbal, as well as written, interrogatories propounded to him, which were not limited to his published writings, or the subject of electricity, but extended to investigations and discoveries in general having a bearing upon the electric telegraph. He gave his testimony at a distance from his notes and manuscripts, and it would not have been surprising if inaccuracies had occurred in some parts of his statement; but all the material points in it are sustained by independent testimony, and that portion which relates directly to Mr. Morse agrees entirely with the statement of his own assistant, Dr. Gale. Had his deposition been objectionable, it ought to have been impeached before the Court; but this was not attempted; and the following tribute to Professor Henry by the Judge, in delivering the opinion of the Supreme Court of the United States, indicates the impression made upon the Court itself by all the testimony in the case: "It is due to him to say that no one has contributed more to enlarge the knowledge of electro-magnetism, and to lay the foundations of the great inventions of which we are speaking, than the Professor himself."

Professor Henry's answers to the first and second interrogatories present a condensed history of the progress of the science of electro-magnet-

ism, as connected with telegraphic communication, embracing an account of the discoveries of Oersted, Arago, Davy, Ampère; of the investigations by Barlow and Sturgeon; of his own researches, commenced in 1828, and continued in 1829, 1830, and subsequently. The details of his experiments and their results, though brief, are very precise. There is abundant evidence to show that Professor Henry's experiments and illustrations at Albany, and subsequently at Princeton, proved, and were declared at the time by him to prove, that the electric telegraph was now practicable; that the electro-magnet might be used to produce mechanical effects at a distance adequate to making signals of various kinds, such as ringing bells, which he practically illustrated. In proof of this, we quote a letter to Professor Henry, from Professor James Hall, of Albany, late president of the American Association for the advancement of Science.

JANUARY 19, 1856.

DEAR SIR: While a student of the Rensselaer School, in Troy, New York, in August, 1832, I visited Albany with a friend, having a letter of introduction to you from Professor Eaton. Our principal object was to see your electro-magnetic apparatus, of which we had heard much, and at the same time the library and collections of the Albany Institute.

You showed us your laboratory in a lower story or basement of the building, and in a larger room in an upper story some electric and galvanic apparatus, with various philosophical instruments. In this room, and extending around the same, was a circuit of wire stretched along the wall, and at one termination of this, in the recess of a window, a bell was fixed, while the other extremity was connected with a galvanic apparatus.

You showed us the manner in which the bell could be made to ring by a current of electricity, transmitted through this wire, and you remarked that this method might be adopted for giving signals, by the ringing of a bell at the distance of many miles from the point of its connection with the galvanic apparatus.

All the circumstances attending this visit to Albany are fresh in my recollection, and during the past years, while so much has been said respecting the invention of electric telegraphs, I have often had occasion to mention the exhibition of your electric telegraph in the Albany Academy, in 1832.

If at any time or under any circumstances this statement can be of service to you in substantiating your claim to such a discovery at the period named, you are at liberty to use it in any manner you please, and I shall be ready at all times to repeat and sustain what I have here stated, with many other attendant circumstances, should they prove of any importance.

I remain, very sincerely and respectfully, yours,

JAMES HALL.

Professor JOSEPH HENRY.

In his deposition, Professor Henry's statements are within what he might fairly have claimed. But he is a man of science, looking for no other reward than the consciousness of having done something for its promotion, and the reputation which the successful prosecution of scientific investigations and discoveries may justly be expected to give. In his public lectures and published writings he has often pointed out incidentally

the possibility of applying the facts and laws of nature discovered by him to practical purposes; he has freely communicated information to those who have sought it from him, among whom has been Mr. Morse himself, as appears by his own acknowledgments. But he has never applied his scientific discoveries to practical ends for his own pecuniary benefit. It was natural, therefore, that he should feel a repugnance to taking any part in the litigation between rival inventors, and it was inevitable that, when forced to give his testimony, he should distinctly point out what was so clear in his own mind and is so fundamental a fact in the history of human progress, the distinctive functions of the discoverer, and the inventor who applies discoveries to practical purposes in the business of life.

Mr. Henry has always done full justice to the invention of Mr. Morse. While he could not sanction the claim of Mr. Morse to the *exclusive* use of the electro-magnet, he has given him full credit for the mechanical contrivances adapted to the application of his invention. In proof of this we refer to his deposition, and present also the following statement of Hon. Charles Mason, Commissioner of Patents, taken from a letter addressed by him to Professor Henry, dated March 31, 1856:

U. S. Patent Office, *March* 31, 1856.

Sir: Agreeably to your request I now make the following statement:

Some two years since, when an application was made for an extension of Prof. Morse's patent, I was for some time in doubt as to the propriety of making that extension. Under these circumstances I consulted with several persons, and among others with yourself, with a view particularly to ascertain the amount of invention fairly due to Professor Morse.

The result of my inquiries was such as to induce me to grant the extension. I will further say that this was in accordance with your express recommendation, and that I was probably more influenced by this recommendation and the information I obtained from you, than by any other circumstance, in coming to that conclusion.

I am, sir, yours very respectfully,
CHARLES MASON.

Prof. J. Henry.

To sum up the result of the preceding investigation in a few words.

We have shown that Mr. Morse himself has acknowledged the value of the discoveries of Professor Henry to his electric telegraph; that his associate and scientific assistant, Dr. Gale, has distinctly affirmed that these discoveries were applied to his telegraph, and that previous to such application it was impossible for Mr. Morse to operate his instrument at a distance; that Professor Henry's experiments were witnessed by Prof. Hall and others in 1832, and that these experiments showed the possibility of transmitting to a distance a force capable of producing mechanical effects adequate to making telegraphic signals; that Mr. Henry's deposition of 1849, which evidently furnished the motive for Mr. Morse's

attack upon him, is strictly correct in all the historical details, and that, so far as it relates to Mr Henry's own claim as a discoverer, is within what he might have claimed with entire justice ; that he gave the deposition reluctantly, and in no spirit of hostility to Mr. Morse ; that on that and other occasions he fully admitted the merit of Mr. Morse as an inventor ; and that Mr. Morse's patent was extended through the influence of the favorable opinion expressed by Professor Henry.

Your committee come unhesitatingly to the conclusion that Mr. Morse has failed to substantiate any one of the charges he has made against Professor Henry, although the burden of proof lay upon him ; and that all the evidence, including the unbiased admissions of Mr. Morse himself, is on the other side. Mr. Morse's charges not only remain unproved, but they are positively disproved.

Your committee recommend the adoption of the following resolutions :

[C.]

Resolved, That Professor Morse has not succeeded in refuting the statements of Professor Henry in the deposition given by the latter in 1849, that he has not proved any one of the accusations against Professor Henry made in the article in Shaffner's Telegraph Companion in 1855, and that he has not disproved any one of his own admissions in regard to Professor Henry's discoveries in electro-magnetism, and their importance to his own invention of the electro-magnetic telegraph.

Resolved, That there is nothing in Professor Morse's article that diminishes, in the least, the confidence of this Board in the integrity of Prof. Henry, or in the value of those great discoveries which have placed his name among those of the most distinguished cultivators of science, and have done much to exalt the scientific reputation of the country.

Resolved, That this report, with the resolutions, be recorded in the Proceedings of the Board of Regents of the Institution.

APPENDIX TO THE REPORT OF THE COMMITTEE.

STATEMENT OF PROF. HENRY,

IN RELATION TO

THE HISTORY OF THE ELECTRO-MAGNETIC TELEGRAPH.

In the beginning of my deposition I was requested to give a sketch of the history of electro-magnetism having a bearing on the telegraph, and the account I then gave from memory, I have since critically examined and find it fully corroborated by reference to the original authorities. My sketch, which was the substance of what I had been in the habit of giving in my lectures, was necessarily very concise, and almost exclusively confined to one class of facts, namely, those having a direct bearing on Mr. Morse's invention, and my paper in Silliman's Journal was likewise very brief and intended merely for scientific men. In order, therefore, to set forth more clearly in what my own improvements consisted, it may be proper to give a few additional particulars respecting some points in the progress of discovery, illustrated by wood cuts.

There are several forms of the electrical telegraph; first, that in which frictional electricity has been proposed to produce sparks and motion of pith balls at a distance.

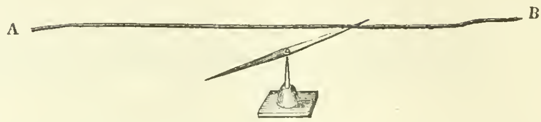
Second, that in which galvanism has been employed to produce signals by means of bubbles of gas from the decomposition of water.

Third, that in which electro-magnetism is the motive power to produce motion at a distance; and again, of the latter there are two kinds of telegraphs, those in which the intelligence is indicated by the motion of a magnetic needle, and those in which sounds and permanent signs are made by the attraction of an electro-magnet. The latter is the class to which Mr. Morse's invention belongs. The following is a brief exposition of the several steps which led to this form of the telegraph.

The first essential fact, as I stated in my testimony, which rendered the electro-magnetic telegraph possible was discovered by Oersted, in the

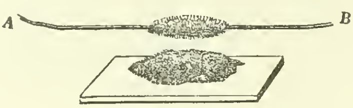
winter of 1819–'20. It is illustrated by figure 1, in which the magnetic needle is deflected by the action of a current of galvanism transmitted through the wire A B. (See Annals of Philosophy, vol. 16, page 273.

Fig. 1.



The second fact of importance, discovered in 1820, by Arago and Davy, is illustrated in figure 2. It consists in this, that while a current of galvanism is passing through a copper wire A B, it is magnetic, it attracts iron filings and not those of copper or brass, and is capable of developing magnetism in soft iron. (See Annales de Chimie, vol. 15, page 94.)

Fig. 2.



The next important discovery, also made in 1820, by Ampère, was that two wires through which galvanic currents are passing in the same direction attract, and in the opposite direction, repel, each other. On this fact Ampère founded his celebrated theory, that magnetism consists merely in the attraction of electrical currents revolving at right angles to the line joining the two poles of the magnet. The magnetisation of a bar of steel or iron, according to this theory, consists in establishing within the metal by induction a series of electrical currents, all revolving in the same direction at right angles to the axis or length of the bar. (See Annales de Chimie, vol. 15, page 69.)

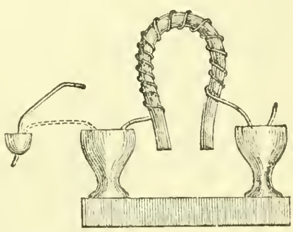
It was this theory which led Arago, as he states, to adopt the method of magnetizing sewing needles and pieces of steel wire, shown in figure 3. This method consists in transmitting a current of electricity through a helix surrounding the needle or wire to be magnetized. For the purpose of insulation the needle was inclosed in a glass tube, and the several turns of the helix were at a distance from each other to insure the passage of electricity, through the whole length of the wire, or, in other words, to prevent it from seeking a shorter passage by cutting across from one spire to another. The helix employed by Arago obviously approximates the arrangement required by the theory of Ampère, in order to develop by induction the magnetism of the iron. By an attentive perusal of the original account of the experiments of Arago, given in the Annales de Chimie et Physique, vol. XV,

Fig. 3.

1820, page 93, it will be seen that, properly speaking, he made no electro-magnet, as has been asserted by Morse and others; his experiments were confined to the magnetism of iron filings, to sewing needles and pieces of steel wire of the diameter of a millimetre, or of about the thickness of a small knitting needle. (See Annales de Chimie, vol. 15, page 95.)

Mr. Sturgeon, in 1825, made an important step in advance of the experiments of Arago, and produced what is properly known as the electro-magnet. He bent a piece of iron *wire* into the form of a horseshoe, covered it with varnish to insulate it, and surrounded it with a helix, of which the spires were at a distance. When a current of galvanism was passed through the helix from a small battery of a single cup the iron wire became magnetic, and continued so during the passage of the current. When the current was interrupted the magnetism disappeared, and thus was produced the first temporary soft iron magnet.

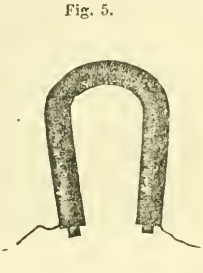
Fig. 4.



The electro-magnet of Sturgeon is shown in figure 4, which is an exact copy from the drawing in the Transactions of the Society for the Encouragement of Arts, &c., vol. xliii. By comparing figures 3 and 4 it will be seen that the helix employed by Sturgeon was of the same kind as that used by Arago; instead, however, of a straight steel wire inclosed in a tube of glass, the former employed a bent wire of soft iron. The difference in the arrangement at first sight might appear to be small, but the difference in the results produced was important, since the temporary magnetism developed in the arrangement of Sturgeon was sufficient to support a weight of several pounds, and an instrument was thus produced of value in future research.

The next improvement was made by myself. After reading an account of the galvanometer of Schweigger, the idea occurred to me that a much nearer approximation to the requirements of the theory of Ampère could be attained by insulating the conducting wire itself, instead of the rod to be magnetized, and by covering the whole surface of the iron with a series of coils in close contact. This was effected by insulating a long wire with silk thread, and winding this around the rod of iron in close coils from one end to the other. The same principle was extended by employing a still longer insulated wire, and winding several strata of this over the first, care being taken to insure the insulation between each stratum by a covering of silk ribbon. By this arrangement the rod was surrounded by a compound helix formed of a long wire of many coils, instead of a single helix of a few coils, (figure 5.)

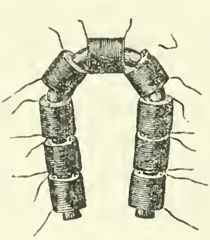
Fig. 5.



In the arrangement of Arago and Sturgeon the several turns of wire were not precisely at right angles to the axis of the rod, as they should be, to produce the effect required by the theory, but slightly oblique, and therefore each tended to develop a separate magnetism not coincident with the axis of the bar. But in winding the wire over itself, the obliquity of the several turns compensated each other, and the resultant action was at right angles to the bar. The arrangement then introduced by myself was superior to those of Arago and Sturgeon, first in the greater multiplicity of turns of wire, and second in the better application of these turns to the development of magnetism. The power of the instrument, with the same amount of galvanic force, was by this arrangement several times increased.

The maximum effect, however, with this arrangement and a single battery was not yet obtained. After a certain length of wire had been coiled upon the iron, the power diminished with a further increase of the number of turns. This was due to the increased resistance which the longer wire offered to the conduction of electricity. Two methods of improvement therefore suggested themselves. The first consisted, not in increasing the length of the coil, but in using a number of separate coils on the same piece of iron. By this arrangement the resistance to the conduction of the electricity was diminished and a greater quantity made to circulate around the iron from the same battery. The second method of producing a similar result consisted in increasing the number of elements of the battery, or, in other words, the projectile force of the electricity, which enabled it to pass through an increased number of turns of wire, and thus, by increasing the length of the wire, to develop the maximum power of the iron.

Fig. 6.



To test these principles on a larger scale, the experimental magnet was constructed, which is shown in figure 6. In this a number of compound helices were placed on the same bar, their ends left projecting, and so numbered that they could be all united into one long helix, or variously combined in sets of lesser length.

From a series of experiments with this and other magnets it was proved that, in order to produce the greatest amount of magnetism from a battery of a single cup, a number of helices is required; but when a compound battery is used, then one long wire must be employed, making many turns around the iron, the length of wire and consequently the number of turns being commensurate with the projectile power of the battery.

In describing the results of my experiments, the terms *intensity* and

quantity magnets were introduced to avoid circumlocution, and were intended to be used merely in a technical sense. By the *intensity* magnet I designated a piece of soft iron, so surrounded with wire that its magnetic power could be called into operation by an *intensity* battery, and by a *quantity* magnet, a piece of iron so surrounded by a number of separate coils, that its magnetism could be fully developed by a *quantity* battery.

I was the first to point out this connection of the two kinds of the battery with the two forms of the magnet, in my paper in Silliman's Journal January, 1831, and clearly to state that when magnetism was to be developed by means of a compound battery, one long coil was to be employed, and when the maximum effect was to be produced by a single battery, a number of single strands were to be used.

These steps in the advance of electro-magnetism, though small, were such as to interest and astonish the scientific world. With the same battery used by Mr. Sturgeon, at least a hundred times more magnetism was produced than could have been obtained by his experiment. The developments were considered at the time of much importance in a scientific point of view, and they subsequently furnished the means by which magneto-electricity, the phenomena of dia-magnetism, and the magnetic effects on polarized light were discovered. They gave rise to the various forms of electro-magnetic machines which have since exercised the ingenuity of inventors in every part of the world, and were of immediate applicability in the introduction of the magnet to telegraphic purposes. Neither the electro-magnet of Sturgeon nor any electro-magnet ever made previous to my investigations was applicable to transmitting power to a distance.

The principles I have developed were properly appreciated by the scientific mind of Dr. Gale, and applied by him to operate Mr. Morse's machine at a distance.

Previous to my investigations the means of developing magnetism in soft iron were imperfectly understood. The electro-magnet made by Sturgeon, and copied by Dana, of New York, was an imperfect quantity magnet, the feeble power of which was developed by a single battery. It was entirely inapplicable to a long circuit with an intensity battery, and no person possessing the requisite scientific knowledge, would have attempted to use it in that connection after reading my paper.

In sending a message to a distance, two circuits are employed, the first a long circuit through which the electricity is sent to the distant station to bring into action the second, a short one, in which is the local battery and magnet for working the machine. In order to give projectile force sufficient to send the power to a distance, it is necessary to use an intensity battery in the long circuit, and in connection with this, at the distant station, a magnet surrounded with many turns of one long

wire must be employed to receive and multiply the effect of the current enfeebled by its transmission through the long conductor. In the local or short circuit either an intensity or a quantity magnet may be employed. If the first be used, then with it a compound battery will be required; and, therefore, on account of the increased resistance due to the greater quantity of acid, a less amount of work will be performed by a given amount of material; and, consequently, though this arrangement is practicable it is by no means economical. In my original paper I state that the advantages of a greater conducting power, from using several wires in the quantity magnet, may, in a less degree, be obtained by substituting for them one large wire; but in this case, on account of the greater obliquity of the spires and other causes, the magnetic effect would be less. In accordance with these principles, the receiving magnet, or that which is introduced into the long circuit, consists of a horse-shoe magnet surrounded with many hundred turns of a single long wire, and is operated with a battery of from 12 to 24 elements or more, while in the local circuit it is customary to employ a battery of one or two elements with a much thicker wire and fewer turns.

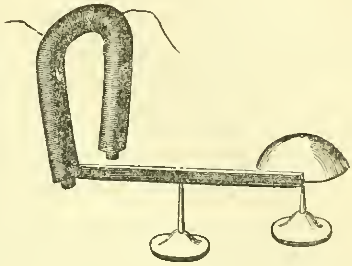
It will, I think, be evident to the impartial reader that these were improvements in the electro-magnet, which first rendered it adequate to the transmission of mechanical power to a distance; and had I omitted all allusion to the telegraph in my paper, the conscientious historian of science would have awarded me some credit, however small might have been the advance which I made. Arago and Sturgeon, in the accounts of their experiments, make no mention of the telegraph, and yet their names always have been and will be associated with the invention. I briefly, however, called attention to the fact of the applicability of my experiments to the construction of the telegraph; but not being familiar with the history of the attempts made in regard to this invention, I called it "Barlow's project," while I ought to have stated that Mr. Barlow's investigation merely tended to disprove the possibility of a telegraph.

I did not refer exclusively to the needle telegraph when, in my paper, I stated that the *magnetic* action of a current from a trough is at least not sensibly diminished by passing through a long wire. This is evident from the fact that the immediate experiment from which this deduction was made was by means of an electro-magnet and not by means of a needle galvanometer.

At the conclusion of the series of experiments which I described in Silliman's Journal, there were two applications of the electro-magnet in my mind: one the production of a machine to be moved by electro-magnetism, and the other the transmission of or calling into action power at a distance. The first was carried into execution in the construction of

the machine described in Silliman's Journal, vol. xx, 1831, and for the purpose of experimenting in regard to the second, I arranged around one of the upper rooms in the Albany Academy a wire of more than a mile in length, through which I was enabled to make signals by sounding a bell, (fig. 7.) The mechanical arrangement for effecting this object was simply a steel bar, permanently magnetized, of about ten inches in length, supported on a pivot, and placed with its north end between the two arms of a horse-shoe magnet. When the latter was excited by the current, the end of the bar thus placed was attracted by one arm of the horse-shoe, and repelled by the other, and was thus caused to move in a horizontal plane and its further extremity to strike a bell suitably adjusted.

Fig. 7.



This arrangement is that which is alluded to in Professor Hall's letter* as having been exhibited to him in 1832. It was not, however, at that time connected with the long wire above mentioned, but with a shorter one put up around the room for exhibition.

At the time of giving my testimony, I was uncertain as to when I had first exhibited this contrivance, but have since definitely settled the fact by the testimony of Hall and others that it was before I left Albany, and abundant evidence can be brought to show that previous to my going to Princeton in November, 1832, my mind was much occupied with the subject of the telegraph, and that I introduced it in my course of instruction to the Senior class in the Academy. I should state, however, that the arrangement that I have described was merely a temporary one, and that I had no idea at the time of abandoning my researches for the practical application of the telegraph. Indeed, my experiments on the transmission of power to a distance were superseded by the investigation of the remarkable phenomena, which I had discovered in the course of these experiments, of the induction of a current in a long wire on itself, and of which I made the first mention in a paper in Silliman's Journal in 1832, vol. xxii.

I also devised a method of breaking a circuit, and thereby causing a large weight to fall. It was intended to illustrate the practicability of calling into action a great power at a distance capable of producing me-

* See the Report of the Committee, page 96, and Proceedings of the Albany Institute, January, 1858.

chanical effects; but as a description of this was not printed, I do not place it in the same category with the experiments of which I published an account, or the facts which could be immediately deduced from my papers in Silliman's Journal.

From a careful investigation of the history of electro-magnetism in its connection with the telegraph, the following facts may be established:

1. Previous to my investigations the means of developing magnetism in soft iron were imperfectly understood, and the electro-magnet which then existed was inapplicable to the transmission of power to a distance.

2. I was the first to prove by actual experiment that, in order to develop magnetic power at a distance, a galvanic battery of intensity must be employed to project the current through the long conductor, and that a magnet surrounded by many turns of one long wire must be used to receive this current.

3. I was the first actually to magnetize a piece of iron at a distance, and to call attention to the fact of the applicability of my experiments to the telegraph.

4. I was the first to actually sound a bell at a distance by means of the electro-magnet.

5. The principles I had developed were applied by Dr. Gale to render Morse's machine effective at a distance.

The results here given were among my earliest experiments; in a scientific point of view I considered them of much less importance than what I subsequently accomplished; and had I not been called upon to give my testimony in regard to them, I would have suffered them to remain without calling public attention to them, a part of the history of science to be judged of by scientific men who are the best qualified to pronounce upon their merits.

DEPOSITION OF JOSEPH HENRY,

IN THE CASE OF

MORSE vs. O'REILLY,

TAKEN AT BOSTON, SEPTEMBER, 1849.

[From the Record of the Supreme Court of the United States.]

1. Please state your place of residence and your occupation; also, what attention, if any, you have given to the subjects of electricity, magnetism, and electro-magnetism.

Answer.—I begin this deposition with the express statement that I do not voluntarily give my testimony; but that I appear on legal summons, and in submission to law. I am Secretary to the Smithsonian Institution, established in the city of Washington, where I now reside. The principal direction of the Institution is confided to me. As I do not expect to return to Washington until some time in October, I have been called upon to give my testimony here in Boston; on this account I labor under the disadvantage of being obliged to testify without my notes and papers, which are now in Washington.

I commenced the study of electro-magnetism in 1827; and since then have, at different times, (until) within the last two and a half years, when I became Secretary of the Smithsonian Institution, made original investigations in this and kindred branches of physical science. I know no person in our country who has paid more attention to the study of the principles of electro-magnetism than myself.

2. Please give a general account of the progress of the science of electro-magnetism, as connected with telegraphic communication; and of any inventions or discoveries in electro-magnetism applicable to the telegraph, made by yourself.

Answer.—I consider an electro-magnetic telegraph as one which operates by the combined influence of electricity and magnetism. Prior to the winter of 1819–'20, no form of the electro-magnetic telegraph was

possible: the scientific principles on which it is founded were then unknown. The first fact of electro-magnetism was discovered by Oersted, of Copenhagen, during that winter. It is this: A wire being placed close above, or below, and parallel to a magnetic needle, and a galvanic current being transmitted through the wire, the needle will tend to place itself at right angles to it. This fact was widely published, and the account was everywhere received with interest.

The second fact of importance was discovered independently, and about the same time, by Arago, at Paris, and Davy, at London. It is this: During the transmission of a galvanic current through a wire of copper, or any other metal, the wire exhibits magnetic properties, attracting iron, but not copper filings, and having the power of inducing permanent magnetism in steel needles. The next important fact was discovered by Ampère, of Paris, one of the most sagacious and successful cultivators of physical science in the present century. It is this: Two parallel wires through which galvanic currents are passing in the same direction, attract each other; but if the currents pass in opposite directions, they repel each other. On this fact Ampère founded his ingenious theory of magnetism and electro-magnetism. According to this theory, all magnetic phenomena result from the attraction or repulsion of electric currents, supposed to exist in the iron at right angles to the length of the bar; and that all the phenomena of magnetism and electro-magnetism are thus referred to one principle, namely, the action of electrical currents on each other.

Ampère deduced from this theory many interesting results, which were afterwards verified by experiment. He also proposed to the French Academy a plan for the application of electro-magnetism to the transmission of intelligence to a distance; this consisted in deflecting a number of needles at the place of receiving intelligence, by galvanic currents transmitted through long wires. This transmission was to be effected by completing a galvanic circuit. When completed, the needle was deflected. When interrupted, it returned to its ordinary position, under the influence of the attraction of the earth. This project of Ampère was never reduced to practice. All these discoveries and results were prior to 1823.

The next investigations relating to the magnetic telegraph were published in 1825; they were by Mr. Barlow, of the Royal Military Academy of Woolwich, England. He found that there was great diminution in the power of a galvanic current to produce effects with an increase of distance; a diminution so great in a distance of two hundred feet was observed, as to convince him of the impracticability of the scheme of the electro-magnetic telegraph. His experiments led him to conclude that the power was inversely as the square root of the length of the wire. The

publication of these results put at rest, for a time, all attempts to construct an electro-magnetic telegraph.

The next investigations, in the order of time, bearing on the telegraph, were made by Mr. Sturgeon, of England. He bent a piece of iron wire into the form of a horse-shoe, and put loosely around it a coil of copper wire, with wide intervals between the turns or spires to prevent them touching each other, and through this coil he transmitted a current of galvanism. The iron, under the influence of this current, became magnetic, and thus was produced the first electro-magnetic magnet, sometimes called simply the electro-magnet. An account of this experiment was first published in November, 1825, in the Transactions of the Society for the Encouragement of the Arts in England; and was made known in this country through the Annals of Philosophy for November, 1826.

Nothing further was done pertaining to the telegraph until my own researches in electro-magnetism, which were commenced in 1828, and continued in 1829, 1830, and subsequently; Barlow's results, as I before observed, had prevented all attempts to construct a magnetic telegraph on the plan of Ampère, and our own knowledge of the development of magnetism in soft iron, as left by Sturgeon, was not such as to be applicable to telegraphic purposes. The electro-magnet of Sturgeon could not be made to act by a current through a long wire, as will be apparent hereafter in this deposition.

After repeating the experiments of Oersted, Ampère, and others, and publishing an account in 1828 of various modifications of electro-magnetic apparatus, I commenced in that year the investigation of the laws of the development of magnetism in soft iron, by means of the electrical current. The first idea that occurred to me in accordance with the theory of Ampère, with reference to increasing the power of the electro-magnet, was that of using a longer wire than had before been employed. A wire of sixty feet in length, covered with silk, was wound round a whole length of an iron bar, either straight or in the form of a U, so as to cover its whole length with several thicknesses of the wire.

The results of this arrangement were such as I had anticipated, and electro-magnets of this kind, exhibited to the Albany Institute in March, 1829, possessed magnetic power superior to that of any ever before known.

The idea afterwards occurred to me that the quantity of galvanism, supplied by a small galvanic battery, might be applied to develop a still greater amount of magnetic power in a large bar of iron. On experiment, I found this idea correct. A battery of two and a half square inches of zinc, developed magnetism in a large bar sufficient to lift fourteen pounds.

The next suggestion which occurred to me was that of using a number

of wires of the same length around the same bar, so as to lessen the resistance which the galvanic current experienced in passing from the zinc to the copper through the coil. To bring this to the test of experiment, a second wire, equal in length to the first, was wound around the last mentioned magnet, and its ends soldered to the plates of the same battery.

The magnet with this additional wire lifted twenty eight pounds, or, in other words, its power was doubled.

A series of experiments was afterwards made, to determine the resistance to conduction of wires of different lengths and diameters, and the proper lengths and number of wires for producing, with different kinds of galvanic batteries, the maximum of amount of magnetic development with a given quantity of zinc surface. For this purpose a bar of soft iron, two inches square and twenty inches long, weighing twenty-one pounds, and much larger than any before used, was bent in the form of a horse-shoe. Around this were wound nine strands of copper wire, each sixty feet long, the ends left projecting so that one or more coils could be used at once, either connected with a battery or with each other, thus forming several coils with several battery connections, or one long coil with single battery connections. The greatest effect obtained with this magnet, using a battery of a single pair, with a zinc plate of two-fifths of a square foot of surface, and all the wire arranged as separate coils, was to lift a weight of six hundred and fifty pounds ; with a large battery the effect was increased to seven hundred and fifty pounds. In a subsequent series of experiments, not published with the preceding, the same magnet was made to sustain one thousand pounds. When a compound battery was employed of a number of pairs, it was found that the greatest effect was produced when all the wires were arranged as a single long coil. I subsequently constructed electro-magnets on the same plan, which supported much greater weights. One of these, now in the cabinet of Princeton, will sustain three thousand six hundred pounds with a battery occupying about a cubic foot of space. It consists of thirty strands of wire, each about forty feet in length.

The abovementioned experiments exhibit the important fact that when a galvanic battery of intensity (that is to say, a battery consisting of a number of pairs) is employed, the electro-magnet connected with it must be wound with one long wire, in order to produce the greatest effect ; and that when a battery of quantity, (that is, one of a single pair,) is employed, the proper form of the magnet connected with it is that in which several shorter wires are wound around the iron. The first of these magnets, which is the one now employed in the long or main circuit of the tele-

graph, may be called an intensity magnet; and the second, which is used in the local circuit, may be denominated the quantity.

The quantity of electricity which can be passed through a long circuit of ordinary sized wire is, under the most favorable circumstances, exceedingly small, and in order that this may develop magnetism in a bar of iron, it was necessary that it should be made to revolve many times around the iron, that its effects may be multiplied; and this is effected by using a long single coil. Hence it will be seen that the electro-magnet of Mr. Sturgeon was not applicable to telegraphic purposes in a long circuit.

Previous to making the last experiments above mentioned, in order to guide myself, I instituted a series of preliminary experiments on the conduction of wires of different lengths and diameters, with different batteries. In these experiments a galvanometer, or an instrument consisting of a magnetic needle freely suspended within a coil of wire, was first employed to denote, by the deflection of its needle, the power of the current. The result from a number of experiments, with a battery of a single pair, was the same as that obtained by Barlow, namely, that the power diminished rapidly with the increase of distance. With the same battery, and a larger wire, the diminution was less. The galvanometer was next removed, and a small electro-magnet substituted in its place. With a single battery, the same result was again obtained—a great diminution of lifting power with the increase of distance. After this the battery of a single pair was removed and its place supplied by one of intensity, consisting of twenty-five pairs. With this the important fact was observed, that no perceptible diminution of the lifting power took place, when the current was transmitted through an intervening wire between the battery and the magnet of upwards of one thousand feet.

This was the first discovery of the fact that a galvanic current could be transmitted to a great distance with so little a diminution of force as to produce mechanical effects, and of the means by which the transmission could be accomplished. I saw that the electric telegraph was now practicable; and, in publishing my experiments and their results, I stated that the fact just mentioned was applicable to Barlow's project of such a telegraph. I had not the paper of Barlow before me, and erred in attributing to him a project of a telegraph, as he only disproved, as he thought, the practicability of one. But the intention of the statement was to show that I had established the fact that a mechanical effect could be produced by the galvanic current at a great distance, operating upon a magnet or needle, and that the telegraph was therefore possible. In arriving at these results, and announcing their applicability to the telegraph, I had not in mind any particular form of telegraph, but referred

only to the general fact that it was now demonstrated that a galvanic current could be transmitted to great distances with sufficient power to produce mechanical effects adequate to the desired object.

The investigations above mentioned were all devised and originated, and the experiments planned, by myself. In conducting the latter, however, I was assisted by Dr. Philip Ten Eyck, of Albany. An account of the whole was published in the 19th volume of Silliman's Journal, in 1831, with the exception of the account of the large magnet afterwards constructed at Princeton in 1833, and the experiment mentioned of lifting a thousand pounds with one of my first magnets. While I was engaged in these researches, Professor Moll, of the University of Utrecht, was pursuing investigations somewhat similar, and succeeded in making powerful electro-magnets, but made no discovery as to the distinction between the two kinds of magnets, or the transmissibility of the galvanic current to a great distance with power to produce mechanical effects. In fact, his experiments were but a repetition on a large scale of those of Sturgeon.

After completing the investigations abovementioned, I commenced a series of experiments on another branch of electricity closely connected, with this subject. Among other things, I applied the principles abovementioned to the construction of an electro-magnetic machine, which has since excited much attention in reference to the application of electro-magnetism as a motive power in the arts.

In 1832 I was called to the chair of natural philosophy in the College of New Jersey, at Princeton, and in my first course of lectures in that institution, in 1833, and in every subsequent year during my connection with that institution, I mentioned the project of the electro-magnetic telegraph, and explained how the electro-magnet might be used to produce mechanical effects at a distance adequate to making signals of various kinds. I never myself attempted to reduce these principles to practice or to apply any of my discoveries to processes in the arts. My whole attention, exclusive of my duties to the college, was devoted to original scientific investigations, and I left to others what I considered in a scientific view of subordinate importance, the application of my discoveries to useful purposes in the arts. Besides this, I partook of the feeling common to men of science, which disinclines them to secure to themselves the advantages of their discoveries by a patent.

In February, 1837, I went to Europe; and early in April of that year Professor Wheatstone, of London, in the course of a visit to him in King's College, London, with Professor Bache, now of the Coast Survey, explained to us his plans of an electro-magnetic telegraph; and, among other things, exhibited to us his method of bringing into action a second

galvanic circuit. This consisted in closing the second circuit by the deflection of a needle, so placed that the two ends projecting upwards, *of* the open circuit, would be united by the contact of the end of the needle when deflected, and on opening or breaking of the circuit so closed by opening the first circuit, and thus interrupting the current, when the needle would resume its ordinary position under the influence of the magnetism of the earth. I informed him that I had devised another method of producing effects somewhat similar. This consisted in opening the circuit of my large quantity magnet at Princeton, when loaded with many hundred pounds weight, by attracting upward a small piece of moveable wire, with a small intensity magnet, connected with a long wire circuit. When the circuit of the large battery was thus broken by an action from a distance, the weights would fall, and great mechanical effect could thus be produced, such as the ringing of church bells at a distance of a hundred miles or more, an illustration which I had previously given to my class at Princeton. My impression is strong, that I had explained the precise process to my class before I went to Europe, but testifying now without the opportunity of reference to my notes, I cannot speak positively. I am, however, certain of having mentioned in my lectures every year previously, at Princeton, the project of ringing bells at a distance, by the use of the electro-magnet, and of having frequently illustrated the principle of transmitting power to a distance to my class, by causing in some cases a thousand pounds to fall on the floor, by merely lifting a piece of wire from two cups of mercury closing the circuit.

The object of Professor Wheatstone, as I understood it, in bringing into action a second circuit, was to provide a remedy for the diminution of force in a long circuit. My object, in the process described by me, was to bring into operation a large quantity magnet, connected with a quantity battery in a local circuit, by means of a small intensity magnet, and an intensity battery at a distance.

The only other scientific facts of importance to the practical operation of the telegraph not already mentioned, are the discovery by Steinheil, in 1837, in Germany, of the practicability of completing a galvanic circuit, by using the earth for completing the circuit, and the construction of the constant battery in 1836, or about that time, by Professor Daniell, of King's College, London. I believe that I was the first to repeat the experiments of Steinheil and Daniell in this country. I stretched a wire from my study to my laboratory, through a distance in the air of several hundred yards, and used the earth as a return conductor, with a very minute battery, the negative element of which was a common pin, such as is used in dress, and the positive element the point of a zinc wire immersed in a single drop of acid. With this arrangement, a needle was

deflected in my laboratory before my class. I afterwards transmitted currents in various directions through the college grounds at Princeton. The exact date of these experiments I am unable to give without reference to my notes. They were previous, however, to the unsuccessful attempt of Mr. Morse to transmit currents of electricity through wires buried in the earth between Washington and Baltimore, and before he attempted to use the earth as a part of the circuit. Previous to this time, and after the abovementioned experiments, Mr. Morse visited me at Princeton, to consult me on the arrangement of his conductors. During this visit, we conversed freely on the subject of insulation and conduction of wires. I urged him to put his wires on poles, and stated to him my experiments and their results.

In the course of the years 1836 and 1837, various plans of more or less merit were devised, and more or less fully carried into effect, for applying the principles already discovered to the construction of electro-magnetic telegraphs in different parts of the world, but of these I do not undertake to give any particular account. I would say, however, that of these plans that for which Mr. Morse subsequently obtained a patent was, in my judgment, the best.

3. Please state whether or not you are acquainted with the electro-magnetic telegraph for which S. F. B. Morse obtained a patent in 1846. If you are, please state whether any, and if any, which of the principles or plans which you have described as discovered, or announced by yourself or others are used in the construction or operation of it. State also what principles used in the telegraph are, so far as you know, original with Professor Morse.

Answer.—I am acquainted with the principles and general mode of operation of the telegraph and improvement referred to. The telegraph is based upon the facts discovered by myself and others, of which I have already given an account.

The plan which was first described to me in the autumn of 1837 by Mr. Morse, or by Professor Gale, who was associated with him in the construction of the telegraph, was to employ a single entire circuit of wire, with an intensity battery to excite the current, and an intensity magnet to receive it and produce a mechanical action, which would work the recording apparatus. Mr. Morse afterwards employed the intensity battery in a long circuit, and an intensity magnet to receive its current at a distant point, and produce the mechanical effect of closing a secondary circuit. The secondary circuit may be either employed to transmit a second current to a distant point and there close a third circuit, and thus continue the line, or for working a recording apparatus in the secondary

circuit, or it may be employed without reference to the continuation of the line, as a short local circuit to work a local magnet. In the first case, there must be in the secondary circuit an intensity battery and intensity magnet; in the last case, a quantity magnet and quantity battery are required.

I heard nothing of the secondary circuit as a part of Mr. Morse's plan until after his return from Europe, whither he went in 1838. It was not till long after this that Mr. Morse used the earth as a part of the circuit in accordance with the discovery of Steinheil.

I am not aware that Mr. Morse ever made a single original discovery, in electricity, magnetism, or electro-magnetism, applicable to the invention of the telegraph. I have always considered his merit to consist in combining and applying the discoveries of others in the invention of a particular instrument and process for telegraphic purposes. I have no means of determining how far this invention is original with himself, or how much is due to those associated with him.

4. Please state when you first became acquainted with Mr. Morse, and what knowledge he possessed of electricity, magnetism, and electro-magnetism, and what information you or others communicated to him relating to the telegraph. State, also, all you know of the attempts of himself, and others associated with him, to construct an electro-magnetic telegraph, either from your own observation or from statements made by himself or by others in your presence. State particularly any conversation, if any, you may have had with him in reference to your own discoveries applied to the telegraph.

Answer.—Shortly after my return from Europe, in the autumn of 1837, I learned that Mr. Morse was about to petition Congress for assistance in constructing the electro-magnetic telegraph. Some of my friends in Princeton, knowing what I had done in developing the principles of the telegraph, urged me to make the representations to Congress, which I expressed some thought of doing, namely: that the principles of the electro-magnetic telegraph belonged to the science of the world, and that any appropriation which might be made by Congress should be a premium for the best plan, and the means of testing the same, which the ingenuity of the country might offer. Shortly after this I visited New York, and there accidentally made the personal acquaintance of Mr. Morse;* he appeared to be an unassuming and prepossessing gentleman, with very little knowledge of the general principles of electricity, magnetism, or electro-

* This meeting took place in the chemical store of Mr. Chilton, Broadway, New York, and the place and time are both indelibly impressed upon my mind.

magnetism. He made no claims, in conversation with me, to any scientific discovery, or to anything beyond his particular machine and process of applying known principles to telegraphic purposes. He explained to me his plan of a telegraph with which he had recently made a successful experiment: I thought this plan better than any with which I had been made acquainted in Europe; I became interested in him, and instead of interfering in his application to Congress, I [subsequently*] gave him a certificate, in the form of a letter, stating my confidence in the practicability of the electro-magnetic telegraph, and my belief that the form proposed by himself was the best which had been published.

Mr. Morse subsequently visited Princeton several times to confer with me on the principles of electricity and magnetism which might be applicable to the telegraph. I freely gave him any information I possessed.

I learned in 1837, or thereabouts, that Professor Gale and Dr. Fisher were the scientific assistants of Mr. Morse in preparing the telegraph. Mr. Vail was also employed, but I know not in what capacity, and I am not personally acquainted with him. With Professor Gale I have been intimately acquainted for several years; he had been a pupil in chemistry of my friend Dr. Torrey, and had studied my papers on electro-magnetism, and, as he informed me, had applied them in the arrangement of the apparatus for the construction of Morse's telegraph.

My researches had been given to the world several years before the attempt was made to reduce the magnetic telegraph to practice. Mr. Chilton, of New York, informed me that he had referred Mr. Morse to them previous to his experiments in the New York University. I was therefore much surprised on the publication, in 1845, of a work purporting to give a history of the telegraph, and of the principles on which it was founded, by Mr. Vail, then principal assistant of Mr. Morse, and one of the proprietors of his patent, to find all my published researches relating to the telegraph passed over with little more than the remark that Dr. Moll and myself had made large electro-magnetic magnets. Presuming that this publication was authorized by Mr. Morse and the proprietors of the telegraph, I complained to some of his friends of the injustice, and after his return from Europe, (for he was absent at the time the book was issued,) I received a letter, copied and signed by Mr. Vail, but written by Mr. Morse, as the latter afterwards informed me, excusing the publication, on the ground that he (Mr. Vail) was ignorant of what I had done, and asking me for an account of my researches. This letter was addressed to me after the book had been stereotyped and widely circulated. It has

* The word subsequently was accidentally omitted in giving my testimony. The omission, however, is of little importance.

been translated into French, and, I believe, published in Paris. To the letter I did not think fit to make any reply. I afterwards received a letter from Mr. Morse, in his own name, on the same subject, to which I gave a verbal reply in January, 1847, in Washington. In this interview Mr. Morse acknowledged that injustice had been done me, but said that proper reparation would be made. Another issue of the same work was made, bearing date 1847, in which there is no change in the statement relative to my researches.

About the beginning of 1848, Mr. Walker, of the Coast Survey, in a report on the application of the telegraph to the determination of differences of longitude, alluded to my researches. A copy of this was sent to Mr. Morse, which led to an interview between Mr. Walker, Professor Gale, Mr. Morse, and myself. At this meeting, which took place at my office in Washington, Mr. Morse stated that he had not known until reading my paper in January, 1847, that I had, two years before his first conception in 1832, settled the point of practicability of the telegraph, and shown how mechanical effects could be produced at a distance, both in the deflection of a needle and in the action of an electro-magnet; that he did not know, at the time of his experiments in 1837 that there had been any doubts of the action of a current at a distance, and that in the confidence of the persuasion that the effect could be produced, he had devised the proper apparatus by which his telegraph was put into operation. Professor Gale, being then referred to, stated that Mr. Morse had forgotten the precise state of the case; that he, (Mr. Morse,) previous to his (Dr. Gale's) connection with him, had not succeeded in producing effects at a distance; that, when he was first called in, he found Mr. Morse attempting to make an electro-magnet act through a circuit of a few yards of copper wire suspended around a room in the University of New York, and that he could not succeed in producing the desired effect even in *this* short circuit; that he (Dr. Gale) asked him if he had studied Prof. Henry's paper on the subject, and that the answer was "no;" that he then informed Mr. Morse that he would find the principles necessary to success explained in that paper; that instead of the battery of a single element, he should employ one of a number of pairs; and that, in place of the magnet with a short single wire, he should use one with a long coil. Dr. Gale further stated that his apparatus was in the same building, and that having articles of the kind he had mentioned, he procured them, and that with these the action was produced through a circuit of half a mile of wire.* To this statement Mr. Morse made no reply. The

* See Dr. Gale's letter of April, 7, 1856, page 93.

interview then terminated, and I have since had no further communication with him on the subject.

5. Please state whether or not you ever constructed any machine for producing motion by magnetic attraction and repulsion ; if yea, what was it, and what led to the making of it.

Answer.—After developing the great magnetic power of the electro-magnet as already described, the thought occurred to me that this power might be applied to give motion to a machine. The simplest arrangement which suggested itself to my mind was one already referred to, namely, causing a movable bar, supported on a horizontal axis like a scale beam, to be attracted and repelled by two permanent magnets. This could be readily effected by transmitting through a coil of wire around the suspended bar, a current of galvanism, first in one direction, and then in the opposite direction, the alternations of the current being produced by dipping the ends of wires projecting from the coils into cups of mercury connected with batteries, one on either side. An account of this was published in Silliman's Journal, for 1831, vol. xx., p. 340. It was the first successful attempt to produce a mechanical motion which might apparently be employed in the arts as a motive power. This little machine attracted much attention at home and abroad, and various modifications of it were made by myself and others. I never, however, regarded it as practically applicable in the arts, because of the great expense of producing power by this means, except, perhaps, in particular cases where expense of power is of little consequence.

6. Please look at the drawings of the Columbian Telegraph, now shown you, marked G. W. B. and N. B. C., and certified by G. S. Hillard, Commissioner. Describe generally the apparatus represented and its mode of operation, and state in what respects, if any, it differs from the telegraphic apparatus patented by Mr. Morse.

Answer.—I have looked at the drawings, and I find, on examination, that it will be impossible for me to give a definite answer to the question, unless I have more time than is now at my disposal, and the means of examining and comparing the operations of the machines.

7. Please state, if you can, how many original experiments you have made in the course of your investigations in electricity, magnetism, and electro-magnetism.

Answer.—The experiments I have mentioned in this deposition form but a small part of my original investigations. Besides many that I made in Albany, which I have not mentioned, since my removal to Princeton,

I have made several thousands on electricity, magnetism, and electro-magnetism, particularly the former, which have more or less bearing on practical applications of this branch of science, brief minutes of which fill several hundred folio pages. Many of these have not been published in detail. They have cost me years of labor and much expense.

The only reward I ever expected was the consciousness of advancing science, the pleasure of discovering new truths, and the scientific reputation to which these labors would entitle me.

JOSEPH HENRY.

Sworn to before me, September 7, 1849.

GEO. S. HILLARD,
Commissioner.

PORTRAITS

OF

NORTH AMERICAN INDIANS,

WITH SKETCHES OF SCENERY, ETC.,

PAINTED BY

J. M. STANLEY.

DEPOSITED WITH

THE SMITHSONIAN INSTITUTION.

WASHINGTON:
SMITHSONIAN INSTITUTION.
DECEMBER, 1852.

PHILADELPHIA:
COLLINS, PRINTER, 705 JAYNE STREET.

PREFACE.

The collection embraced in this Catalogue comprises accurate portraits painted from life of forty-three different tribes of Indians, obtained at the cost, hazard, and inconvenience of a ten years' tour through the South-western Prairies, New Mexico, California, and Oregon. Of course, but a short description of the characters represented or of the leading incidents in their lives is given. But even these brief sketches, it is hoped, will not fail to interest those who look at their portraits, and excite some desire that the memory, at least, of these tribes may not become extinct.

J. M. STANLEY.

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SEMINOLES.

The Seminoles originally belonged to the Creek family; but, owing to some internal dissensions, they left them and formed a separate and independent band. The Creeks gave them the appellation of *Seminoles*, which signifies "runaways." On their removal west of the Mississippi, the government assigned to them a portion of the Creek country; but being unwilling to come under the then existing Creek laws, they refused to occupy it, and took up their abode in the Cherokee nation, in the vicinity of Fort Gibson. Here they resided until the spring of 1845, when they met the Creeks in council; and through the exertions of Major Wm. Armstrong, Superintendent of Indian Affairs in the South-west, Gov. P. M. Butler, Cherokee Agent, and Col. Jas. Logan, Creek Agent, their causes of dissatisfaction were removed, and they accordingly took up their abode in the Creek Nation, upon the waters of Little River.

1.

CO-WOCK-COO-CHEE, OR WILDCAT.

(Painted Dec. 1842.)

A Seminole Chief, and one of the most celebrated of his tribe; possessed of much vanity and an indomitable spirit, he has won for himself an exalted name and standing among his people.

At the outbreak of the Florida War, he was a mere boy; but he shouldered his rifle, and fought with so much courage and desperation, that he was soon looked up to as a master-spirit. This gathered a band of warriors about him, who adopted him as their chief leader. At the head of this party he became a formidable enemy of the United States troops, and gave them much trouble during that campaign, and probably would never have fallen into the hands of the whites, had he been able to procure food and ammunition for his band: being reduced to a state of starvation, he was obliged to surrender, and, by treaty stipulations with the United States Government, was with his people removed west of the Mississippi.

2.

AL-LECK TUSTENUGGEE.

(Painted Dec. 1842.)

This Chief is at the head of the Mikasukie band, and during the Florida War was one of the most active among the Seminoles.

During this war, his band perpetrated some of the most cruel murders on record; among them was that of Mrs. Montgomery, who was brutally massacred while riding on horseback, within a short distance of the post, where her husband, Lieut. Montgomery, of the U. S. A., was stationed. Since the removal of his people west of the Mississippi, they have been quite peaceable, but not altogether contented. Great numbers have died from local diseases, and the intemperate use of whiskey, which they procure on the frontier.

He inquired particularly after the health of Gen. Worth, of the U. S. A., of whom he spoke in the highest terms. He wore many ornaments and articles of dress, the gifts of that distinguished officer.

I asked of him the privilege of painting one of his wives. He replied that his women had been hunted through the everglades of Florida until they were unfit to be seen; but whenever they recruited, he would not object to their being painted.

3.

NOKE-SUKE TUSTENUGGEE.

(Painted Dec. 1842.)

A Seminole Sub-chief of the Mikasukie band. A warrior of distinction, and Al-leck Tustenuggee's aid.

4.

AL-LECK TUSTENUGGEE, NOKE-SUKE TUSTENUGGEE, CUDJO, and GEO. W. CLARKE.

(Painted Dec. 1842.)

Cudjo is a negro Interpreter, who served the United States during the Florida War; and Geo. W. Clarke is Seminole Agent.

5.

TUSTENUGGEE CHOP-KO, OR THE BIG WARRIOR.

(Painted Dec. 1842.)

A Seminole Mikasukie Sub-chief, and one of the most distinguished warriors of his tribe. He is six feet three inches in height, and well proportioned, and is esteemed one of the best ball-players among his people. His countenance indicates any thing but intelligence or shrewdness; on the contrary, it exhibits evidence of a capacity to commit any act, however cruel and atrocious, at the bidding of his chief. He is said to have cut off the hands of Mrs. Montgomery after her murder, for the purpose of procuring the rings upon her fingers.

6.

CHO-CO-TE TUSTENUGGEE.

(Painted Dec. 1842.)

A Sub-chief, of some note as a warrior, but abandoned and dissipated; he is painted in the costume in which he presented himself, with a bottle of "fire-water" in his hand. He possesses an amiable disposition, and is passionately fond of joking, which has acquired for him the celebrity of punster to the band.

7.

HAL-BURTA-HADJO, OR ALLIGATOR.

(Painted Aug. 1843.)

A Seminole Chief, celebrated for his prowess as a warrior. His name has been frequently before the public, as the instigator and perpetrator of many atrocious murders, during the Florida campaign. He has suffered much from sickness since his removal, and looks dejected and careworn.

8.

COT-SA, OR TIGER.

(Painted Dec. 1842.)

A Seminole Warrior, and son of Alligator.

9.

SEM-I-WOC-CA.

(Painted Sept. 1843.)

Represented as about crossing a small stream, with a corn-basket under her arm. She is attired in the costume peculiar to the Creek and Seminole women. Their dress consists of calico, of a coarse, cheap kind, worked to the depth of from twelve to fifteen inches from the bottom with different colours, in various devices.

I found it exceedingly difficult to get the women of this tribe to sit for their pictures, owing to the opposition of their chiefs, who do not consider them worthy of such an honour.

CREEKS.

THESE people formerly resided in Georgia and Alabama, but were removed by the United States Government in 1836, and are now residing on the Arkansas, seven hundred miles west of the Mississippi. They are somewhat advanced in civilization and the arts. They mostly follow agricultural pursuits, having extensive farms and many negroes. The principal productions of the soil are corn and sweet potatoes; they raise some cotton, from which they manufacture a very substantial cloth, suitable to their own wants. Vegetables of almost every description are produced in abundance. They raise large stocks of horses, hogs, and cattle, to which their country is well adapted, being mostly prairie, and one of the finest grazing countries in the world.

They adhere tenaciously to all their ancient customs, with a superstitious awe and veneration, having among them their rain-makers, medicine or mystery men, in the potency of whose charms they are firm believers.

10.

OPOETH-LE-YO-HOLO.

(Painted July, 1843.)

Speaker of the Upper Creeks. "This man holds the rank of principal counsellor, or speaker of the councils, over which he presides with great dignity. His influence is so great, that the questions submitted to council are generally decided according to his will; for his tribe consider him as the organ of their chief, and suppose he only speaks as he is directed.

"His power is such over them, that they have frequently requested him to submit himself as a candidate for the principal chieftainship; but he prefers his position as speaker, which brings him more immediately in contact with his people, and gives him the advantage of displaying his address and eloquence.

"During the late unhappy contest between the United States and the Seminole Indians, it was to be expected that the sympathies of the Creeks would be strongly excited in favour of the latter, who are a wandering tribe, descendants from the Creek nation. Accordingly, in 1836, when the war grew hot, and the Seminoles were successful in several sanguinary engagements, the spirit of revolt spread through the Creek nation, and many of that people were urged, by the fatal destiny which seemed to have doomed that whole race to extinction, into open war. Sau-gah-at-chee, one of the towns of Opoeth-le-yo-holo's district, was the first to revolt. The warriors, without a single exception, painted themselves for war; the young men rushed out upon the highways, and murdered all the travellers who fell in their way. Opoeth-le-yo-holo, on hearing the intelligence, immediately placed himself at the head of the warriors of his own town, marched upon the insurgents, burned their village, and, having captured some of their men, delivered them over to the military, by whom they were imprisoned."—*McKinney.*

11.

OPOETH-LE-YO-HOLO.

(1843.)

Represented in the manner in which he paints himself when going to war. One would hardly recognise this celebrated chief in this disguise. He insisted on being thus painted, and it was with diffi-

culty that he was afterwards induced to wash his face, and sit for a portrait which his friends would be able to recognise. See No. 10.

12.

A CREEK BUFFALO DANCE.

(Painted Aug. 1843.)

This dance is enacted every year during the season of their busk or green-corn dances; and the men, women, and children, all take an active part in the ceremony. They invest themselves with the scalp of the buffalo, with the horns and tail attached, and dance about in a circle, uttering sounds in imitation of the animal they represent, with their bodies in a half-bent position, supporting their weight upon their ball-sticks, which represent the forelegs of the buffalo.

13.

TUSTENUGGEE EMATHLA.

(Painted June, 1843.)

"This is a fine-looking man, six feet and one inch in height, and well proportioned, of manly and martial appearance and great physical strength, and is well calculated to command the respect of a band of savage warriors. He is generally known by the name of Jim Boy. Tustenuggee means 'warrior;' and Emathla, 'next to the warrior.'

"He is and always has been a firm and undeviating friend of the whites: he led a party of seven hundred and seventy-six warriors to Florida, and endeavoured, first as mediator, to induce the Seminoles to abandon the bloody and fruitless contest in which they were engaged, but was unsuccessful.

"Soon after his arrival at Tampa, he joined the camp of Col. Lane, by whom he was sent, with two hundred of his warriors, to look after the Seminoles. He fell in with a party of the latter, and drove them into a swamp, from which they opened a fire, and wounded several of his men. He was then sent to meet Gov. Call, and arrived at the spot where Gen. Gaines was surrounded, soon after that officer had been relieved. On the following day, he joined Gov. Call, and proceeded to Fort Drane, where the Seminoles, though numerous, refused them battle, fled, and were pursued. The Creeks were unable to overtake them; but the Tennessee horse fell in with them on the following day, and a fight ensued, in which several were killed on

each side. Tustenuggee Emathla and his party joined the army again at Fort Dade; and the Seminoles being in a swamp hard by, an attack was planned, in which the Creeks were invited to go foremost, an honour which they promptly declined, while they cheerfully agreed to advance side by side with the white men. In this fight the Creeks lost four men, besides one who was accidentally killed by the whites, but the Seminoles were beaten. He was afterwards sent to a place towards St. Augustine for provisions, and was in several skirmishes not worth recording.

"He says he joined our army under a promise made by the commanding general, that in the removal of his people west of the Mississippi, about to take place, his property and family should be attended to, and that he should be indemnified for any loss that might happen in consequence of his absence. These stipulations, he alleges, were broken by the removal of his women and children, while he was absent in the service of the government, whereby his entire property was destroyed. Nor was this the worst of his misfortunes. His family, consisting of a wife and nine children, were among the unfortunate persons who were on board of the steamboat Monmouth, when that vessel was sunk by the mismanagement of those to whose care it was intrusted, and two hundred and thirty-six of the Creeks, including four of his children, were drowned. Melancholy as such an occurrence would be under any circumstances, the catastrophe is infinitely the more deplorable when happening to an ignorant people, while emigrating, unwillingly, under the charge of our public agents, and to a people whose whole intercourse with the whites has tended to render them suspicious of the faith of civilized men."—*McKinney.*

He speaks English quite fluently, but will not converse with a man unless well acquainted with him; and he will not then speak it, in the presence of the Indians, lest he should compromise the dignity characteristic of Indian greatness. For his interference in the Florida war, he has entailed upon himself the lasting hatred of the Seminoles: they hold him in such utter abhorrence and detestation, that they would never look upon his portrait, while in my studio, without manifesting dissatisfaction and disgust.

He is about fifty-two years of age, vigorous and active, and is still able to undergo much fatigue and hardship. He is beloved and respected by his people, and is one of the leading men of his nation.

14.

TO-MATH-LA-MICCO, or THE LITTLE KING.

(Painted June, 1843.)

Principal Chief of the Upper Creeks. Distinguished only as a Warrior, he was elected to the chieftainship through the instrumentality of Opoeth-le-yo-holo, who has great influence over him. He is painted in the attitude of holding a red stick, which is invariably carried by him, during the ceremonies of the busk or green-corn dance. It is emblematical of the red-stick or late Creek war.

Possessing no merit as an orator or counsellor, his will is easily swayed by his speaker. He is mild and amiable in his disposition, and much beloved by his people.

15.

TUCK-A-BACK-A-MICCO, or THE MEDICINE-MAN or PHYSIC-MAKER.

(Painted June, 1843.)

This is the great Medicine or Mystery Man of the Creeks; his fields of corn are cultivated by the people of the town in which he resides, and a salary of five hundred dollars per annum is allowed him from the treasury of the nation, for his services.

They suppose him to be indued with supernatural powers, and capable of making it rain copiously at will.

In his town is a building of rather a singular and peculiar construction, used during their annual busk or green-corn dances as a dancing-house. It is of a circular form, about sixty feet in diameter and thirty feet high, built of logs; and was planned by this man in the following manner:—

He cut sticks in miniature of every log required in the construction of the building, and distributed them proportionately among the residents of the town, whose duty it was to cut logs corresponding with their sticks, and deliver them upon the ground appropriated for the building, at a given time. At the raising of the house, not a log was cut or changed from its original destination; all came together in their appropriate places, as intended by the designer. During the planning of this building, which occupied him six days, he did not partake of the least particle of food.

He has in his possession, and wears, a medal said to have been presented to his parents by Gen. Washington.

He is painted in the costume which he usually wears.

16.

TAH-COO-SAH FIXICO, OR BILLY HARDJO.

(Painted Aug. 1843.)

Chief of one of the Upper Creek towns. He is a merchant or trader among his people; also, has an extensive farm and several negro slaves, which enable him to live very comfortably. He is much beloved and respected by his people. The dress in which he is painted is that of a ball-player, as they at first appear upon the ground. During the play they divest themselves of all their ornaments, which are usually displayed on these occasions, for the purpose of betting on the result of the play: such is their passion for betting, that the opposing parties frequently bet from five hundred to a thousand dollars on a single game.

17.

CHILLY McINTOSH.

(Painted June, 1843.)

An Upper Creek Chief. This man is a brother of Gen. McIntosh, who was killed some years since by his people, for negotiating a treaty with the United States Government, contrary to the laws of his country. Chilly was pursued by the same party who massacred his brother, but succeeded in making his escape by swimming a river, which arrested his pursuers.

"Menawa, who is called the *Great* Warrior, was commissioned by the chiefs to raise a party to march to the Indian Springs and execute the judgment of their law upon McIntosh on his own hearth-stone. With the usual promptitude of the Indians in the prosecution of bloody business, Menawa was soon at the head of one hundred of his Oakfuskee braves, and, after a rapid march, arrived before the house of the fated McIntosh before day, on the morning of the first of May, just seventy-seven days after the signing of the treaty. The house having been surrounded, Menawa spoke:—'Let the white people who are in the house come out, and also the women and children. We come not to injure them. McIntosh has broken the law made by himself, and we are come to take his life.'"

This summons was obeyed by all to whom it was addressed. Chilly, who, having signed the treaty, was in the list of meditated victims, was enabled by his light complexion to pass out with the whites, and escaped.

Out of this occurrence arose two parties among the Creek Indians. One was composed of the bulk of the nation—the other of the followers of McIntosh, headed by Chilly.

He speaks English fluently, and has seen much of civilized life, having spent much time at Washington, transacting business with the heads of Departments, in behalf of his people. He is among the first men of his nation.

18.

KEE-SEE-LAH AND AH-SEE-HEE.

(Painted Aug. 1843.)

Daughters of Opoeth-le-yo-holo. The latter is commonly denominated the Young Queen. The remaining figure on the right is a half-breed and the wife of a white trader.

CHEROKEES.

This nation's territory borders on Arkansas and Missouri. They are a semi-civilized people, and are more advanced in the arts and agriculture than any other Indian Nation. They number about twenty thousand souls. Most of them cultivate the soil with much success. Their farms are cultivated by slaves, of which they own great numbers. Corn is the staple production of the soil, although they raise some small grain, and enough cotton for home consumption. Many of them manufacture cloth sufficient for themselves and slaves. They display much taste in the formation of their patterns, many of which are truly beautiful. A sample may be found among the various Indian Curiosities attached to the Gallery.

The National Authorities have established schools in every district throughout the nation, and engaged competent teachers to take charge of them. Missionaries of various denominations are assiduously engaged among them, from whose pious and exemplary conduct they are receiving lasting benefits.

19.

COO-WIS-COO-EE, OR JOHN ROSS.

(Painted Sept. 1844.)

Principal Chief of the Cherokees. Mr. Ross has been for a number of years at the head of his people, which fact is sufficient evidence of the high estimation in which they hold him as a man capable of discharging the responsible duties devolving upon the office. Mr. R. is a man of education, and as a statesman would do honour to the legislative halls of any country. His hospitality is unbounded; from his soft and bland manners, his guests are at once made to feel at home, and forget that they are far from the busy scenes of civilization, and surrounded by the red men of the forest. His house is the refuge of the poor, starved, and naked Indian; when hungry, he is sure to find at the abode of this exemplary man something wherewith to appease his hunger, and if naked, a garment to cover his nakedness. Of his private and political history much might be said; but we leave it to those who are more competent to the task, and able to do him that justice due to so eminent a man.

20.

KEETH-LA, OR DOG.

(Painted 1844.)

Commonly called Major George Lowery, Second or Assistant Chief of the Cherokees; an office which he has filled for a number of years with much credit to himself and the entire satisfaction of his people. He is about seventy years of age, speaks English fluently, and is an exemplary Christian.

He is painted in the attitude of explaining the wampum, a tradition of the manner in which peace was first brought about among the the various Indian tribes. (See No. 27.)

21.

STAN WATIE.

(Painted June, 1843.)

A highly gifted and talented Cherokee. This man is a brother of Boudinot, who was murdered some years since for his participation in negotiating with the United States the New Echota treaty, (which has caused so much internal dissension among the Cherokees,) contrary to the laws of his country. Stan Watie was also one of the signers of that instrument, but has thus far escaped the horrible death that befell his brother. He is reputed to be one of the bravest men of his people. During the session of the International Council, at Tah-le-quah, in June, 1843, he sat for his portrait; he was surrounded by hundreds of his enemies at the time, but did not manifest the least symptoms of fear during his sojourn. A biography of this man's life would form a very interesting volume.

22.

THOMAS WATIE.

(Painted 1842.)

Brother of Stan Watie, a fine-looking man, but abandoned and dissipated. He is a printer by trade, and speaks English fluently and writes a good hand.

23.

YEAH-WEE-OO-YAH-GEE, or THE SPOILED PERSON.

(Painted 1844.)

This man was one of the signers of the first treaty made with the Cherokees by the United States Government, during the administration of General Washington. He says he was at that time quite a young warrior, but he distinctly recollects how the General looked, and all that took place. He describes the manner in which the Indians were received by their Great Father as follows:—"The white men stood like geese flying, the Great Father standing at the head. The Indians were told by the interpreter, that they must not shake hands with any one until they had shaken the hand of their Great Father; they all passed through the centre, and each in his turn shook him by the hand." He also gave an amusing description of the dinner which was prepared for them on that occasion.

During the Creek war he fought with the whites against the Creeks, and at the battle of Horse Shoe received several wounds. He is now about 88 years of age, and receives a pension from the United States for his services during that war: he is still in the full enjoyment of all his faculties, having ridden thirty miles on horseback to sit for the portrait now exhibited.

24.

OH-TAH-NEE-UN-TAH, or CATCHER.

(Painted 1844.)

A Cherokee Warrior.

25.

CHARLES McINTOSH.

(Painted 1842.)

A Cherokee half-breed, about twenty-three years of age, little known among his people until December, 1842. He then distinguished himself by killing a man upon the Prairies, by the name of Merrett, an escaped convict from the jail at Van Buren, Arkansas, who with his brother was under sentence to the State Prison, had escaped, and fled to the Prairies, where they carried on a sort of land piracy, robbing and murdering all travellers whom chance threw into their power.

26.

WE-CHA-LAH-NAE-HE, or THE SPIRIT.

(Painted 1844.)

Commonly called John Huss. A regular ordained minister of the Presbyterian denomination, and speaks no English. He is a very pious and good man. The following letter, written in the Cherokee language, which I received from him, will give the reader some idea of the situation of the people under his pastoral charge.

Tah-le-quah, Cherokee Nation,
January 30*th*, 1844.

My Friend:—You wish that I should tell you something about the Cherokees living on Honey Creek. I suppose you wish to know whether the people are acting as a civilized or uncivilized people I am very glad to hear that you wish to know something about the

Cherokees. I will write to you in Cherokee, it being the only language which I can write. I cannot write the English language as the Whites. You can get some person to interpret this for you.

When we came to this country and settled on Honey Creek, there were but few who emigrated from east of the Mississippi, that formerly were connected with the church, who had settled in this place; but now there are a great many, and we have built a house of God, and on the Sabbath-day we pray to him at that place, and we have the gospel of God preached to us, and we meet here every Sabbath. The people attend to what is said during divine service, and we have a Sunday-school. The children attend to learn to read, both in Cherokee and English; we have also formed a Temperance Society, and have met once, which was on the first of the month; it was a very cold day, and only few attended, but I think about fifty signed the pledge. We have lately formed a Bible Society in this neighbourhood, and have met once. There were about thirty subscribed their names to give money to buy good books. There were only twenty dollars received. In this manner the people are gradually improving under the influence of the gospel, and I believe they have become acquainted with God and his Son.

I am your ob't servant,
JOHN HUSS.

27.

INTERNATIONAL INDIAN COUNCIL.

(Painted 1843.)

This council was convened by John Ross, at Tah-le-quah, in the Cherokee Nation, in the month of June, 1843, and continued in session four weeks. Delegates from seventeen tribes were present, and the whole assemblage numbered some ten thousand Indians. During the session, each of the chiefs and warriors of the several delegations delivered a "talk;" but want of space compels us to confine ourselves to the explanation of the wampum belt, and the speech of Mr. Ross.

Major George Lowrey, Second Chief of the Cherokees, (No. 20,) in explanation of the wampum, spoke as follows:—

"You will now hear a talk from our forefathers. You must not think hard, if we make a few mistakes in describing our wampum; if we do, we will try and rectify them.

"My BROTHERS, you will now hear what our forefathers said to us.

"In the first place, the Senecas, a great many years ago, devised a plan for us to become friends. When this plan was first laid, the Seneca rose up and said, I fear the Cherokee, because the tomahawk is stuck in several parts of his head. The Seneca afterward remarked, that he saw the tomahawk still sticking in all parts of the Cherokee's head, and heard him whooping and hallooing say that he was too strong to die. The Seneca further said: Our warriors in old times used to go to war; when they did go, they always went to fight the Cherokees; sometimes one or two would return home—sometimes none. He further said, The Great Spirit must love the Cherokees, and we must be in the wrong, going to war with them. The Seneca then said, Suppose we make friends with the Cherokee, and wash his wounds and cause them to heal up, that he may grow larger than he was before. The Seneca, after thus speaking, sat down. The Wyandot then rose and said, You have done right, and let it be. I am your youngest brother, and you are our oldest. This word was told to the Shawnees: they replied, We are glad, let it be; you are our elder brothers. The Senecas then said, they would go about and pray to the Great Spirit for four years to assist them in making peace, and that they would set aside a vessel of water and cover it, and at the end of every year they would take the cover off, and examine the water, which they did: every time they opened it, they found it was changed; at the end of four years they uncovered the vessel and found that the water had changed to a colour that suited them. The Seneca then said, The Great Spirit has had mercy upon us, and the thing has taken place just as we wished it.

"The Shawnee then said, We will make straight paths; but let us make peace among our neighbouring tribes first, before we make this path to those afar off.

"The Seneca then said, Before we make peace, we must give our neighbouring tribes some fire; for it will not do to make peace without it,—they might be travelling about, and run against each other, and probably cause them to hurt each other. These three tribes said, before making peace that this fire which was to be given to them should be kindled in order that a big light may be raised, so they may see each other at a long distance; this is to last so long as the earth stands; they said further, that this law of peace shall last from generation to generation—so long as there shall be a red man living on this earth; they also said, that the fire shall continue

among us and shall never be extinguished as long as one remains. The Seneca further said to the Shawnees, I have put a belt around you, and have tied up the talk in a bundle, and placed it on your backs; we will now make a path on which we will pass to the Sioux. The Seneca said further, You shall continue your path until it shall reach the lodge of the Osage. When the talk was brought to the Sioux, they replied, We feel thankful to you and will take your talk; we can see a light through the path you have made for us.

"When the Shawnee brought the talk to the Osages, they replied, By to-morrow, by the middle of the day, we shall have finished our business. The Osage said further, The Great Spirit has been kind to me; he has brought something to me, I being fatigued hunting for it. When the Shawnee returned to the lodge of the Osages, they were informed that they were to be killed, and they immediately ly made their escape.

"When the Shawnees returned to their homes whence they came, they said they had been near being killed.

"The Seneca then said to the Shawnees, that the Osages must be mistaken. They sent them back to them again. The Shawnees went again to see the Osages—they told them their business. The Osages remarked, The Great Spirit has been good to us,—to-morrow by the middle of the day he will give us something without fatigue. When the Shawnees arrived at the lodge, an old man of the Osages told them that they had better make their escape; that if they did not, by the middle of the following day, they were all to be destroyed, and directed them to the nearest point of the woods. The Shawnees made their escape about midday. They discovered the Osages following them, and threw away their packs, reserving the bag their talk was in, and arrived at their camp safe. When the Shawnees arrived home, they said they had come near being killed, and the Osages refused to receive their talk. The Seneca then said, If the Osages will not take our talk, let them remain as they are; and when the rising generation shall become as one, the Osages shall be like some herb standing alone. The Seneca further said, The Osages shall be like a lone cherry-tree, standing in the prairies, where the birds of all kinds shall light upon it at pleasure. The reason this talk was made about the Osages was, that they prided themselves upon their warriors and manhood, and did not wish to make peace

"The Seneca further said, We have succeeded in making peace with

all the Northern and neighbouring tribes. The Seneca then said to the Shawnees, You must now turn your course to the South: you must make your path to the Cherokees, and even make it into their houses. When the Shawnees started at night they took up their camp and sat up all night, praying to the Great Spirit to enable them to arrive in peace and safety among the Cherokees. The Shawnees still kept their course, until they reached a place called Tah-le-quah, where they arrived in safety, as they wished, and there met the chiefs and warriors of the Cherokees. When they arrived near Tah-le-quah, they went to a house and sent two men to the head chiefs. The chief's daughter was the only person in the house. As soon as she saw them, she went out and met them, and shook them by the hand and asked them into the house to sit down. The men were all in the field at work—the girl's father was with them. She ran and told him that there were two men in the house, and that they were enemies. The chief immediately ran to the house and shook them by the hand, and stood at the door. The Cherokees all assembled around the house, and said, Let us kill them, for they are enemies. Some of the men said No, the chief's daughter has taken them by the hand; so also has our chief. The men then became better satisfied. The chief asked the two men if they were alone. They answered, no; that there were some more with them. He told them to go after them and bring them to his house. When these two men returned with the rest of their people, the chief asked them what their business was. They then opened this valuable bundle, and told him that it contained a talk for peace. The chief told them, I cannot do business alone; all the chiefs are assembled at a place called Cho-qua-ta, where I will attend to your business in general council. When the messengers of peace arrived at Cho-qua-ta, they were kindly received by the chiefs, who told them they would gladly receive their talk of peace. The messengers of peace then said to the Cherokees, We will make a path for you to travel in, and the rising generation may do the same,—we also will keep it swept clean and white, so that the rising generation may travel in peace. The Shawnee further said, We will keep the doors of our houses open, so that when the rising generation come among us they shall be welcome; he further said, This talk is intended for all the different tribes of our red brothers, and is to last to the end of time; he further said, I have made a fire out of the dry elm—this fire is for all the different tribes to see by. I have put one chunk toward the rising sun, one

toward the setting sun, one toward the north, and one toward the south. This fire is not to be extinguished so long as time lasts. I shall stick up a stick close by this fire, in order that it may frequently be stirred, and raise a light for the rising generation to see by; if any one should turn in the dark, you must catch him by the hand, and lead him to the light, so that he can see that he was wrong.

"I have made you a fire-light, I have stripped some white hickory bark and set it up against the tree, in order that when you wish to remove this fire, you can take it and put it on the bark; when you kindle this fire it will be seen rising up toward the heavens. I will see it and know it; I am your oldest brother. The messenger of peace further said, I have prepared white benches for you, and leaned the white pipe against them, and when you eat you shall have but one dish and one spoon. We have done every thing that was good, but our warriors still hold their tomahawks in their hands, as if they wished to fight each other. We will now take their tomahawks from them and bury them; we must bury them deep under the earth where there is water; and there must be winds, which we wish to blow them so far that our warriors may never see them again.

"The messenger further said, Where there is blood spilt I will wipe it up clean—wherever bones have been scattered, I have taken them and buried them, and covered them with white hickory bark and a white cloth—there must be no more blood spilt; our warriors must not recollect it any more; our warriors said that the Cherokees were working for the rising generation by themselves; we must take hold and help them.

"The messengers then said that you Cherokees are placed now under the centre of the sun; this talk I leave with you for the different tribes, and when you talk it, our voice shall be loud enough to be heard over this island. This is all I have to say."

Mr. Ross then arose and addressed the Council as follows:

"BROTHERS: The talk of our forefathers has been spoken, and you have listened to it. You have also smoked the pipe of peace, and shaken the right hand of friendship around the Great Council-fire, newly kindled at Tah-le-quah, in the west, and our hearts have been made glad on the interesting occasion.

"Brothers: When we look into the history of our race, we see some green spots that are pleasing to us. We also find many things to make the heart sad. When we look upon the first council-fire kindled by our forefathers, when the pipe of peace was smoked in

brotherly friendship between the different nations of red people, our hearts rejoice in the goodness of our Creator in having thus united the heart and hand of the red man in peace.

"For it is in peace only that our women and children can enjoy happiness and increase in numbers.

"By peace our condition has been improved in the pursuit of civilized life. We should, therefore, extend the hand of friendship from tribe to tribe, until peace shall be established between every nation of red men within the reach of our voice.

"Brothers: When we call to mind the only associations which endeared us to the land which gave birth to our ancestors, where we have been brought up in peace to taste the benefits of civilized life; and when we see that our ancient fire has there been extinguished, and our people compelled to remove to a new and distant country, we cannot but feel sorry; but the designs of Providence, in the course of events, are mysterious—we should not, therefore, despair of once more enjoying the blessings of peace in our new homes.

"Brothers: By this removal, tribes that were once separated by distance have become neighbours, and some of them, hitherto not known to each other, have met and become acquainted. There are, however, numerous other tribes to whom we are still strangers.

"Brothers: It is for reviving here in the west the ancient talk of our forefathers, and of perpetuating for ever the old fire and pipe of peace brought from the east, and of extending them from nation to nation, and for adopting such international laws as may be necessary to redress the wrongs which may be done by individuals of our respective nations upon each other, that you have been invited to attend the present council.

"Brothers, let us so then act that the peace and friendship which so happily existed between our forefathers, may be for ever preserved; and that we may always live as brothers of the same family."

The following compact was then introduced by Mr. Ross, for the deliberation and action of the council:—

"*Whereas*, the removal of the Indian tribes from the homes of their fathers, east of the Mississippi, has there extinguished our ancient council-fires, and changed our position in regard to each other; and whereas, by the solemn pledge of treaties, we are assured by the government of the United States that the lands which we now possess shall be the undisturbed home of ourselves and our posterity for ever. *Therefore*, we the authorized representatives of the several

nations, parties hereunto assembled around the Great Council-fire, kindled in the west, at Tah-le-quah, in order to preserve the existence of our race, to revive and cultivate friendly relations between our several communities, to secure to all their respective rights, and to promote the general welfare, do enter into the following compact:

"1st. Peace and friendship shall be for ever maintained between the parties to this compact, and between their respective citizens.

"2d. Revenge shall not be cherished, nor retaliation practised for offences committed by individuals.

"3d. To provide for the improvement of our people in agriculture, manufactures, and other domestic arts, adapted to promote the comfort and happiness of our women and children, a fixed and permanent location on our lands is an indispensable condition. In order, therefore, to secure those important objects, to prevent any future removal, and to transmit to our posterity an unimpaired title to lands guarantied to our respective nations by the United States, we hereby solemnly pledge ourselves to each other, that no nation, party to this compact, shall, without the consent of all the other parties, cede, or in any manner alienate to the United States any part of their present territory.

"4th. If a citizen of one nation commit wilful murder, or other crimes, within the limits of another nation, party hereto, he shall be subject to the same treatment as if he were a citizen of that nation. In cases of property stolen, or taken by force or fraud, the property, if found, shall be restored to the owner; but if not found, the convicted person shall pay the full value thereof.

"5th. If a citizen of any nation, party to this compact, shall commit murder or other crime, and flee from justice into the territory of any other party hereto, such criminal shall, on demand of the principal chief of the nation from which he fled, (accompanied with reasonable proof of his guilt,) be delivered up to the authorities of the nation having jurisdiction of the crime.

"6th. We hereby further agree, that if any of our respective citizens shall commit murder or other crime upon the person of any such citizen in any place beyond the limits of our several territories, the person so offending shall be subject to the same treatment as if the offence had been committed within the limits of his own nation.

"7th. Any citizen of one nation may be admitted to citizenship in any other nation, party hereto, by the consent of the proper authorities of such nation.

"8th. The use of ardent spirits being a fruitful source of crime and misfortune, we recommend its suppression within our respective limits; and agree that no citizen of one nation shall introduce them into the territory of any other nation, party to this compact."

The foregoing compact was, however, only signed by two or three tribes; it was something new to the delegates, and a project they did not feel authorized to act upon without consulting their respective constituents; each delegation was furnished with a copy for future deliberation and action.

Although the council failed in its main object, we doubt not that much good will result from the commingling of so many different tribes, who have often been arrayed against each other in deadly strife, upon the immense plains which supplies most of them with the means of subsistence.

During the whole session the utmost good feeling and harmony prevailed; the business was brought to a close at sundown, after which the various tribes joined in dancing, which was usually kept up to a late hour.

28.

THREE CHEROKEE LADIES.

(Painted 1842.)

29.

TWO CHEROKEE GIRLS.

(Painted 1842.)

30.

CADDO COVE, CADDO CREEK, ARKANSAS.

(Painted 1843.)

Gov. P. M. Butler and party on their return from council with the wild Indians.

31.

VIEW OF THE ARKANSAS VALLEY FROM MAGAZINE MOUNTAIN.

(Painted 1844.)

32.

NATURAL DAM IN CRAWFORD COUNTY, ARKANSAS.

(Painted 1844.)

33.

VIEW OF DARDANELLE ROCK ON THE ARKANSAS.

(Painted 1844.)

CHICKASAW.

34.

ISH-TON-NO-YES, OR JAMES GAMBLE.

(Painted 1843.)

Chickasaw Interpreter. A young man of education, and speaks English fluently.

POTOWATOMIES.

These people formerly owned and occupied a large tract of land in Michigan, and have by treaty stipulations been removed west of the Mississippi; they are at present located on the Missouri, in the vicinity of Council Bluffs. A portion of them raise some corn and a few vegetables, but do not cultivate the soil to any great extent. They are supposed to have originally belonged to the Chippewa family, as their language, manners, and customs bear a similarity to them.

35.

WA-BON-SEH, OR THE WHITE SKY.

(Painted June, 1843.)

Principal Chief of the Prairie Band of Potowatomies, residing near Council Bluffs. This chief is a bold and sagacious warrior, but possesses no merit as an orator; his will is submitted to his people through his speaker, a man possessed of great powers of oratory.

Many of his war exploits are of a thrilling and exciting nature; but the want of room compels us to restrict ourselves to one or two instances only of his firmness and bold daring.

Some years since, a war-party of Osages visited their country and made an unexpected attack upon them, killing many of their warriors and escaping with their scalps. Immediate retaliation was out of the question. Years passed away, during which time many of his people died with the small-pox and intemperate use of whiskey, thereby reducing his warriors to a mere handful. Notwithstanding this dire calamity, Wabonseh still cherished that spirit of revenge so dear to an Indian's heart, and determined to avenge the death of his people.

He accordingly collected a small party, visited the Osage country, and made a descent upon one of their villages, which contained triple their own number of warriors. Nothing daunted, he determined to make an attack. They consequently secreted themselves in the neighbourhood, and waited the approach of night. It was dark and cloudy, and well suited to their purposes. A spy was despatched to learn the position of their enemies, with orders to return to camp when the Osages were slumbering. About midnight he made his appearance, bringing the intelligence that all was quiet. Wa-bon-seh and his party made their way to the village, crept upon the warriors who lay sleeping around the embers of their camp-fires, unconscious of the fate that awaited them. At a signal from the chief the work of death commenced; those who escaped this fate were aroused by the noise, and fled in terror.

Wa-bon-seh, having been successful in procuring the scalps of several of their warriors, did not pursue them, but set fire to their lodges, and made good his retreat. At sunrise they were far on their way towards their homes.

This man was in attendance at the great international council held at Tah-le-quah, in the Cherokee nation, during the month of June,

1843. Shortly after his arrival he entered the camp of his old enemies, the Osages. The old chief, Black Dog, and some six of his warriors were seated upon the ground, busily engaged in mending their moccasins, and did not for some time perceive him. After maintaining silence for some time, and gazing upon the timeworn visage of the Osage chief, he asked him, through the interpreter, if he recollected the facts above alluded to. Black Dog replied, that he remembered the circumstance well; he then told him that he was the warrior who led the party upon that occasion. Black Dog and his party immediately sprang to their feet, and each in his turn shook the venerable chief by the hand, and assured him that hereafter they would be firm and lasting friends. The pipe of peace was then lit, and they sat down to enjoy a friendly smoke.

This little circumstance tends to show the friendly feeling that existed among the several tribes assembled upon that occasion.

"In 1812, he and his tribe were among the allies of Great Britain, and actively engaged against the United States. But at the treaty held at Greenville, in 1814, he was one of those, who, in the Indian phrase, took the seventeen fires by the hand and buried the tomahawk. He has ever since been an undeviating friend of the American government and people.

"He was one of the chiefs who negotiated the treaty of the Wabash in 1836. At the close of the treaty, and while encamped on the bank of the river near the spot where the town of Huntingdon now stands, he engaged in a frolic, and indulged too freely in ardent spirits. A mad scene ensued, such as usually attends a savage revel, in the course of which, a warrior who had the station of friend or aid to Wa-bon-seh, accidentally plunged his knife deep in the side of the chief. The wound was dangerous, and confined him all winter; but Gen. Tipton, then agent of our government in that quarter, having kindly attended to him, he was carefully nursed, and survived. His sometime friend, fearing that he might be considered as having forfeited that character, had fled as soon as he was sober enough to be conscious of his own unlucky agency in the tragic scene.

"Early in the spring, Gen. Tipton was surprised by a visit from Wa-bon-seh, who came to announce his own recovery, and thank the agent for his kindness. The latter seized the occasion to effect a reconciliation between the chief and his fugitive friend, urging upon the former the accidental nature of the injury, and the sorrow and alarm of the offender. Wa-bon-seh replied instantly, 'You may send

to him and tell him to come back—a man that will run off like a dog with his tail down, for fear of death, is not worth killing. I will not hurt him.' We are pleased to say he kept his word."—*McKinney*.

36.

OP-TE-GEE-ZHEEK, or HALF-DAY.

(Painted June, 1843.)

Principal Speaker and Counsellor of the Potowatomies. This man is justly celebrated for his powers of oratory. By his dignity of manner, and the soft and silvery tones of his voice, he succeeds admirably in gaining the most profound attention of all within hearing. At the council which he attended in the Cherokee nation he attracted universal attention, both from his eloquence and the singularity of his dress, the style of which he probably obtained from the Catholic missionaries residing upon the frontier.

37.

NA-SWA-GA, or THE FEATHERED ARROW.

(Painted 1843.)

Principal Chief of a band of Potowatomies, residing on the waters of Little Osage River; he is distinguished as a bold warrior.

STOCKBRIDGES.

38.

THOMAS HENDRICK.

(Painted 1843.)

Principal Chief of the Stockbridges. Of this tribe but few are living, and they have united themselves with the Delawares, with whom they cultivate the soil in common. This man speaks good English, and is very affable in his manners.

MUNSEES.

39.

JIM GRAY.

(Painted 1843.)

Principal Chief of the Munsees, a small tribe residing with the Delawares.

OTTAWAS.

40.

SHAB-A-NEE.

(Painted 1843.)

An Ottawa Chief. This man is well known throughout the northern part of Michigan and Illinois, his people having formerly occupied and owned the soil in that region. During the late war he was one of the most prominent actors, and one of Tecumseh's counsellors and aides-de-camp. He says he was near Tecumseh when he fell, and represents him as having been stabbed through the body with a bayonet, by a soldier: he seized the gun with his left hand, raised his tomahawk, and was about to despatch him, when an officer, wearing a *chapeau* and riding a white horse, approached him, drew a pistol from his holster, and shot him. He and the remaining few of his people reside with the Potowatomies, near Council Bluffs, on the Missouri.

CHIPPEWAS.

41.

SAUSH-BUX-CUM, OR BEAVER DRAGGING A LIMB.

(Painted 1843.)

A CHIPPEWA CHIEF. This man is chief of a small band of Chippewas, residing in the Potowatomie country; these are more advanced in civilization than those living on the Northern Lakes; they are not unlike the Potowatomies in their manners and customs.

DELAWARES.

THE history of this once powerful tribe is recorded in the early settlements of Pennsylvania, New Jersey, Delaware, Ohio, Indiana, and Illinois. There is perhaps no tribe who have been more encroached upon by the whites, or who have more manfully resisted civilized invasion, as they have been forced from the graves and hunting-grounds of their forefathers, than the Delawares. They now occupy a small tract of country west of the Missouri river, and subsist by cultivation.

42.

CAPT. KETCHUM.

(Painted 1843.)

A Delaware Chief.

43.

SECOND EYE.

(Painted 1843.)

A Delaware Chief.

44.

RO-KA-NOO-WHA, THE LONG TRAVELLER.

(Painted 1843.)

Commonly called Jim Second Eye, Head War-Chief of the Delawares.

Some years since, a small band of Delawares, while on a hunting and trapping expedition on the Upper Missouri, were surprised by a large party of Sioux, who fell upon them and murdered all but one of the party, who succeeded in making good his escape and returned to his people. Second Eye immediately started with a small force to avenge the death of his warriors; after travelling several weeks, they fell in with the identical party who committed the depredation. The Sioux, anticipating an attack, retreated to a deep ravine in the mountains in order to defend themselves more advantageously. Second Eye, perceiving the many disadvantages under which he laboured, but having an indomitable spirit, determined to surmount all obstacles, and obtain that vengeance which the death of his warriors loudly called for. He waited until all was quiet within the ravine, raised the war-whoop, rushed madly upon them, and massacred the whole party; he having with his own hands cut off the heads of sixteen Sioux, which he threw to his warriors to scalp.

He speaks some English, and is frequently employed by the United States and Texas as a "*runner*" to the wild Indians, with whom he carries on a very successful trade. He derives his name of Long Traveller from the fact that he has crossed the mountains to Oregon, and has visited Santa Fé, California, and the Navahoe Village.

45.

AH-LEN-I-WEES.

(Painted 1843.)

A Delaware Warrior of distinction in his tribe.

46.

CAPT. McCALLAH.

(Painted 1843.)

Principal Chief of the Texan Delawares. This man is very influential among his people; he also exerts a great influence over the wild Indians, and his presence is considered indispensable at all

councils convened either by the United States or Texas, for the purpose of negotiating treaties.

47.

PA-CON-DA-LIN-QUA-ING, or ROASTING EARS.

(Painted 1843.)

Second or Assistant Chief of the Texan Delawares, and Principal Orator and Councillor.

The following is the interpretation of a speech he made at a council on the river Brasos, called by the government of Texas, and to which council Gov. P. M. Butler was sent as commissioner on the part of the United States, to assist the Texan commissioners in making a treaty with the wild Indians:—

"Friends: I am much pleased to meet you here at this hour of the morning.

"Dear Brothers: I am rejoiced to see the course you are pursuing in this business. I am likewise much pleased to hear that which you have spoken. Understanding that you were about to enter into this business, and having the welfare of my people at heart, I now appear before you. I wish you, my friends, to endeavour to make peace with our red brothers; and I pledge myself to aid and assist you all in my power. It will be very well that you implicitly obey the orders of your chief. I do not wish you, my friends, to notice things of little importance, but to turn your attention to things which deserve it, and I will act in the same manner. The Great Spirit is now looking down upon us, and will mark whether we are now telling the truth; and if he find we do, he will cause the peace we are about to make to be religiously kept.

"My Friends: I wish to go hand in hand with you. The treaty must affect alike both men and women; and I also tell you, that you must prevent your young men from committing depredations on my red brothers, and I will do the same with mine.

"Gov. Butler has been sent here by our great and mutual father, the President of the United States, to witness the treaty we are about to enter into. Let this not be children's play, but as men who are determined on entering into the firm bonds of friendship and peace. For the present I have but little to say, but what I have spoken is true, and it came from my heart. While I stand in the midst of this assemblage, I am at a loss for words to express my ideas. You will therefore excuse me for the present."

WEEAHS.

48.

WAH-PONG-GA, OR THE SWAN.

(Painted 1843.)

PRINCIPAL Chief of the Weeahs. Once a powerful tribe, but now reduced to the small number of two hundred warriors. They formerly resided in Indiana, and are at present located with the Piankeshaws, about forty miles south of Fort Leavenworth, on the Missouri.

SHAWNEES.

THE history of this once powerful tribe is so closely connected with that of the United States in the revolutionary and last war, that it is pretty well understood. They formerly occupied the states of Pennsylvania and New Jersey, and for many years past a part of the states of Indiana and Ohio.

They now occupy a rich tract of country west of the Missouri River, enjoying all the comforts of a civilized life.

49.

QUAH-GOM-MEE.

(Painted 1843.)

Principal Chief of the Shawnees.

50.

SHAC-EE-SHU-MOO.

(Painted 1843.)

An hereditary Shawnee Chief.

51.

PAH-QUE-SAH-AH, OR LITTLE TECUMSEH.

(Painted 1843.)

A son of Tecumseh. He has none of the extraordinary traits of character for which his sire was celebrated, and is of very little note in his tribe; he was in the battle in which his father fell.

SACS AND FOXES.

52.

KEOKUK.—HEAD CHIEF.

(Painted May, 1846.)

"The former residence of the Sacs was on the banks of the St. Lawrence, where they were driven by the Six Nations, with whom they carried on a long and bloody war. As they retired toward the west, they became embroiled with the Wyandots, and were driven farther and farther along the shores of the lakes, until they found a temporary resting-place at Green Bay.

"Here they were joined by the Musquakees, (Foxes,) who, having been so reduced by war as to be unable to maintain themselves as a separate people, sought refuge among their kindred. They subsequently removed to Illinois on Rock River; where, surrounded by the choicest beauties of nature, it would seem that a taste for the picturesque, a sense of the enjoyment of home and comfort, and an ardent love of country would have been implanted and fostered. But we find no such results—and the Sacs of Illinois presented the same character half a century ago which they now exhibit. They are savages as little ameliorated by place or circumstance as the Camanches—or other of the wild Prairie tribes.

"In early life he distinguished himself by killing a Sioux warrior

with a spear, under circumstances which rendered the exploit conspicuous—and for which he was feasted.

"Shortly after this event, and while Keokuk was yet too young to be admitted to the council, a rumour reached the village that a large body of American troops was approaching to attack it. So formidable was this enemy considered, that, although still distant, and the object of the expedition not certainly ascertained, a great panic was excited by the intelligence, and the council, after revolving the whole matter, decided upon abandoning the village. Keokuk, who stood near the entrance of the council-lodge awaiting the result, no sooner heard this determination than he stepped forward and begged to be admitted.

"The request was granted. He asked permission to address the council, which was accorded; and he stood up for the first time to speak before a public assemblage.

"Having stated that he had heard with sorrow the decision of his elder brethren, he proceeded, with modesty, but with the earnestness of a gallant spirit, to deprecate an ignominious flight before an enemy still far distant, whose numbers might be exaggerated, and whose destination was unknown.

"He pointed out the advantages of meeting the foe, harassing their march, cutting them up in detail, driving them back, if possible, and finally of dying honourably in defence of their homes, their women, and their children, rather than yielding all that was dear and valuable without striking a blow. 'Make me your leader,' he exclaimed, 'let your young men follow me, and the pale-faces shall be driven back to their towns. Let the old men and the women, and all who are afraid to meet the white man, stay here; but let your braves go to battle: I will lead them.' This spirited address revived the drooping courage of the tribe,—the recent decision was reversed, and Keokuk was appointed to lead the braves against the invaders.

"The alarm turned out to be false; and after several days' march it was ascertained that the Americans had taken a different course. But the gallantry and eloquence of Keokuk, in changing the pusillanimous policy at first adopted, his energy in organizing the expedition, and the talent for command discovered in the march, placed him in the first rank of braves of the nation.

"The entire absence of records, by which the chronology of events might be ascertained, renders it impossible to trace, in the order of their date, the steps by which this remarkable man rose to the chief

place of his nation, and acquired a commanding and permanent influence over his people.

"Keokuk is in all respects a magnificent savage. Bold, enterprising, and impulsive, he is also politic, and possesses an intimate knowledge of human nature, and a tact which enables him to bring the resources of his mind into prompt operation. His talents as a military chief and civil ruler are evident from the discipline which exists among his people.

"This portrait was painted in the spring of 1846, on the Kansas River, where he, with his people, were temporarily residing after their removal from the Desmoines River.

"He said he had been painted before, when he was a young man, and they had represented him as a war-chief, but that he was now an old man, and wished to be painted with his peace-pipe."—*McKinney.*

53.

SAC CHIEF, AND FOX BRAVE.

(Painted May, 1846.)

54.

KEP-PEO-LECK, OR RED WOLF.

(Painted May, 1846.)

55.

SAC WAR CHIEF, IN WAR PAINT.

(Painted May, 1846.)

56.

WIFE AND DAUGHTER OF BLACK HAWK.

(Painted May, 1842.)

57.

MEDICINE DANCE OF THE SACS.

(Painted May, 1846.)

The Medicine Dance of the Sacs is performed once every year, for the purpose of initiating the mystery or medicine-men into this sacred custom of their tribe.

On this occasion the spirits of all who have died through the year (or since the holding of their annual ceremony) are relinquished to the Great Spirit; and notwithstanding months may have elapsed since death, the great principle of life, the spirit which never dies, does not wing its flight to the land of the happy hunting-grounds until it is set free by the potent charm of the medicine-man.

The names of the deceased are called out, when the father or other near relative steps forward, and in a long speech relates the war or other exploits which distinguished him through life. The chiefs and relatives endorse the recital with hearty grunts of approbation, and the spirit, having been previously prepared with provisions for his journey, is supposed to leave the body.

The lodge consecrated to these mystic rites is made of rush-mats, stretched over poles in the form of an arch, and fifty feet in length. Appemus, the chief physic-maker, and his assistants, attired in the robes of their office, dance through the lodge, holding in both hands, in an horizontal position, a highly ornamented otter-skin medicine-pouch. In the dance, the otter-skin is made to imitate the animal it represents, and with its nose to the ground, and carefully up the sides of the lodge, as in the act of scenting any thing that may affect the charm of his medicine or offend the Great Spirit. The chiefs seated in the lodge are often obliged to move their seats, as the sagacious animal continues to scent the ground upon which they sit, as if suspecting that something might be concealed.

The dance is continued in a careful manner until the lodge is thoroughly examined. During this part of the ceremony, the squaws, gaily clad in embroidered dresses, are arranged around the interior of the lodge, facing the centre, and dancing sideways in slow and measured step, in time to the drum, which they accompany with their voices. After the medicine-men are satisfied with the otter's scenting of the lodge, they deposit their medicine-bags upon the ground, and, apparently overcome with their efforts, fall prostrate, writhing as if in great bodily pain; placing their hands on different parts of the body, as the pain shifts from limb to limb, until, overcome by a severe fit of coughing, they vomit a white bean. With this magical bean they perform wonderful cures and all the superstitious rites of their profession on this occasion.

All the medicine-men having procured the bean in like manner, they take their medicine-bags, and with the bean in the palm of the hand proceed around the lodge, and exhibit it to the chiefs and war

riors, who give evident signs of satisfaction by emphatic grunts of approbation. The bean is then put in the medicine-pouch and held in the manner before described, and the dance continued with more rapidity and energy, the performers making a low grumbling sound, in imitation of the animals whose skins they hold. This is continued some minutes with a spirited step and action of the figure, when they commence shooting the bean from the medicine-pouch at the chiefs and braves, and sometimes at the medicine-men assisting in the ceremony, who immediately fall, and in writhing contortions of the limbs and face vomit the bean, and resume their seats or places in the dance.

The ground is sometimes covered with prostrate figures, uttering cries and groans of pain, mingling with their wild chants and monotonous drum, forming a scene as wild and interesting as it was curious and novel.

This part of the ceremony continued about one hour, and, like all their religious rites, was conducted with great solemnity. The ground around the lodge was crowded with visitors from three Sacs villages, and some eight hundred were witnessing the grand fête.

At this time, the guard, composed of some sixty of Keokuk's principal braves, dressed in their war-paint, and wearing all their trophies of the battle and chase, armed with spears, war-clubs, and bows, and mounted on their favourite horses, painted and decorated with feathers, came charging madly around the medicine-lodge, putting to flight scores of women and children.

The principal war-chief approached the mouth of the medicine-lodge and related his war exploits, the number of scalps he had taken to entitle him to the honour of the post he occupied as chief brave and one of the guards of the medicine-lodge.

Appemus, his squaw, and a young warrior, and several medicine-men of lesser attainments in the mystical rites, danced slowly around, with heads inclined towards the ground, halting at the end of the lodge, speaking with great energy and spirit of the virtues and heroism of the persons of his town who had died the past year, and more particularly of his son (a young warrior) and daughter, saying that he now yielded them to the Great Spirit, and wishing them a pleasant journey on the white path to the happy hunting-grounds.

His wife and a young brave were then prepared for initiation in the mysteries of medicine-lodge. They first spread down upon the ground a piece of broadcloth and calico; the squaw and brave were

then placed in a kneeling posture on one end of the cloth to receive the medicine. The medicine-men commence their dance on the opposite end of the cloth—slowly at first—but as they approach their subjects they become more energetic, and when within a few feet of them, they shoot them with the magical bean—they fall senseless and lifeless. The medicine-men rub them with their medicine-bags, breathe in their faces, and chafe their limbs until they are partially restored. They are then denuded of their clothes, and rapped in the cloth upon which they knelt, in which they remain until the bean is vomited up, which is exhibited to the chiefs. They are then dressed in a new suit, and the same scene again performed upon other subjects; after which, a general dance comes off, in which all take a part. Then follows the feast. The guests are invited by the presentation of a short stick, marked with devices. Being a medicine-man, I had the honour of participating in this part of the ceremony.

58.

THE CHIEFTAIN'S GRAVE.

(Painted Jan. 1851.)

A form of burial practised by many tribes inhabiting the borders of Missouri and Iowa.

BLACK-FOOT.

59.

FLIGHT OF A MOUNTAIN TRAPPER.

(Painted 1851.)

The flight of a Mountain Trapper from a band of Black-Foot Indians, constitutes an incident in the life of Capt. Joe Meek, the present marshal of Oregon Territory. He was a native of Ohio, and early in life enlisted in the service of the American Fur Company as a trapper; in which service he spent eighteen years in the Rocky Mountains.

This picture represents one of the many thrilling incidents in his life, characteristic of the trapper and pioneer. Finding himself pursued by a large party, he hoped, by the aid of a well-bred American horse, to escape a personal encounter; but the Indians, taking advantage of the broken country, soon overtook him, and were showering their arrows at him while in full pursuit, using their horses as a shield. Joe, reserving his fire for a favourable moment, selected the war-chief who was foremost, and, with well-directed aim, hit both horse and rider, which caused them to abandon the pursuit.

Joe was one of the early pioneer residents of Oregon, and one of its first representatives under the provisional government.

60.

THE TRAPPER'S ESCAPE.

(Painted 1851.)

Joe is seen in the middle ground of the picture, waving his gun in exultation at his lucky escape.

61.

BLACK-FOOT INDIANS IN AMBUSH, AWAITING THE APPROACH OF AN EMIGRANT PARTY.

(Painted 1852.)

A composition characteristic of Indian warfare.

OSAGES.

The territory of this tribe adjoins that of the Cherokees.

They cultivate some corn, but depend mostly upon the chase for subsistence, and repel all attempts towards civilization. The influence exerted over their neighbours, the Cherokees and Creeks, by the introduction of missionary and civilized arts among them, has but little weight with them.

One admirable trait in their character is, however, worthy of remark, viz. their aversion to ardent spirits. Such is their abhorrence of the "fire-water," as they term it, that they cannot be induced to drink it. This may be thought strange, but it is nevertheless true. It is generally supposed that all Indians are passionately fond of it, those particularly who are brought more immediately into contact with the whites. We note this fact as an exception to the general rule.

They possess a great passion for thieving, which they gratify upon every occasion; and, like the Spartans, they deem it one of the attributes of a great man to pilfer from his neighbour or friend and avoid detection. Any thing placed in their possession they will take the best care of and defend with their lives. When called upon, it will be restored; but the next instant they will steal it, if they can do so without being detected.

Among the collection will be found a portrait of one of the principal chiefs, and some of his warriors.

We regret to say that we have not portraits of their women, but shall endeavour to procure them at some future period.

62.

TECHONG-TA-SABA, OR BLACK DOG.

(Painted 1843.)

Principal Chief of the Osages. A man six feet six inches in height, and well proportioned, weighing some two hundred and fifty pounds, and rather inclined to corpulency. He is blind of one eye. He is celebrated more for his feats in war than as a counsellor; his opinions are, however, sought in all matters of importance appertaining to the welfare of his people. The name Black Dog was given to him from a circumstance which happened some years since, when on a war expedition against the Comanches. He, with his party, were about to surprise their camp on a very dark night, when a black dog, by his continued barking, kept them at bay. After several ineffectual attempts, being repelled by the dog, Techong-ta-saba became exasperated, and fired an arrow at random, hitting him in the head and causing instant death. By this name he is familiarly known to the officers of the army and white traders in that section of country.

In the latter part of the summer of 1843, a party of fifteen Pawnees went on a trading expedition among the Comanches: having been

prosperous in their enterprise, and feeling themselves secure from the attack of enemies on their route homeward, they were induced to barter most of their guns, ammunition, and a few of their horses, of which the Comanches stood much in need. They then took their departure homeward. At the Wichetaw village they halted for a few days to recruit. An Osage, sojourning with the Wichetaws, seeing the large amount of skins in the possession of the Pawnees, and learning their defenceless situation, immediately mounted his horse, proceeded homeward, and informed Black Dog of the facts. Knowing the trail the Pawnees would take on their route, he immediately started with a war-party for the point they were expected to pass, on the head waters of Canadian River, where they lay in wait for them. Several days elapsed, during which time they sent out runners in every direction to give notice of the approach of the Pawnees. They were at last espied, wending their way leisurely along, unconscious of their close proximity to their deadliest enemies—their horses laden with the fruits of months of fatigue and hardship, destined for the white trader in exchange for guns, ammunition, and blankets. The Osages were in active preparation for the attack. They secreted themselves and awaited the approach of the Pawnees, when they suddenly fell upon and massacred the whole party, securing all their peltries, horses, &c. They departed for their town in savage exultation at the death of their enemies; happy undoubtedly in the belief that they had done their people good service, and enriched themselves without toil.

63.

SHU-ME-CUSS, or WOLF.

(Painted 1843.)

A nephew of Black Dog, and a warrior of distinction among his people.

64.

CROW-SUN-TAH, or BIG SOLDIER.

(Painted 1843.)

An Osage Chief and Brave; is about seventy years of age, vigorous and active. He, together with a number of his tribe, were taken to France some years since by an American citizen for the purpose of giving exhibitions of their various dances. After having made a

large sum of money by the operation, he abandoned them, leaving them entirely destitute of money and a protector. In this situation they contracted disease incidental to the climate, and most of them died. La Fayette, being in Paris, found Crow-sun-tah and a woman, the only survivors, and took them home with him, treated them with the utmost kindness, and finally sent them home to the American government, by whom they were again restored to their people and the quiet of their native forest. He wore a medal presented him by La Fayette, which he prizes above every thing on earth; he often spoke of him and his kind treatment.

He was in attendance at the large International Council held at Tah-le-quah, in the Cherokee Nation, during the month of June, 1843, and participated in the various dances and amusements with as much zest as any of the young warriors. He spent a week with me the following September. He died during the summer of 1844.

65.

NE-QUA-BA-NAH.

(Painted 1843.)

An Osage Warrior.

66.

CHA-PAH-CAH-HA, or EAGLE FEATHER.

(Painted 1843.)

An Osage Warrior. His head-dress is composed of the skin from the head of a buffalo, with the horns attached.

67.

THE OSAGE MIMIC.

(Painted 1843.)

This picture is painted from an incident that took place in my studio at Tah-le-quah, in the Cherokee nation, during the session of the International Council, in 1843.

I was often absent for a short time, sketching, and listening to the various speeches made in council. My door being of rather a rude construction, fastened only by a common wooden latch, all Indians who chose had free ingress. Among those who paid me frequent visits, was an Osage boy, about seventeen years of age, by the

name of Wash-cot-sa, an hereditary chief, possessed of an amiable disposition and inquiring mind. He seemed to observe every thing going on in my studio, and would endeavour to imitate any thing done by me. On one occasion I had been absent for a short time, and during the interim he and one of his companions sauntered in; and finding themselves alone, he concluded to try his hand at painting. He assumed the palette and brushes, placed his subject in a favourable position, and had made some few chalk-marks upon the canvas, when I entered; he immediately discovered me, and, dropping the palette and brushes and pointing to the canvas, said it was *pe-shee* very bad. I endeavoured to induce him to return to his work, but to no purpose.

He expressed a great desire to learn English, and would endeavour to repeat every thing he heard spoken, without knowing the meaning of it: at every visit he would ask me by signs to count for him, which I would do, he repeating after me; then he would count in his own language for me to repeat after him in like manner. At the close of the council, Mr. Ross, Principal Chief of the Cherokees, induced him to remain with him to learn the English language; he however staid but a short time; for, hearing of a skirmish between his own people and the Pawnees, he immediately left for his own country, regretting that he had lost so favourable an opportunity of distinguishing himself as a warrior.

68.

AN OSAGE SCALP-DANCE.

(Painted 1845.)

All tribes of wild Indians scalp their captives, save the women and children, who are treated as slaves, until ransomed by the United States Government.

On returning from the scene of strife, they celebrate their victories by a scalp-dance. The chiefs and warriors, after having painted themselves, each after his own fancy, to give himself the most hideous appearance, encircle their captives, who are all placed together. Thus stationed, at a tap on their drums, they commence throwing themselves into attitudes, such as each one's imagination suggests as the most savage, accompanied by yells, for the purpose of striking terror into the hearts of their captives.

This picture represents the scalp-dance of the Osages around a

woman and her child; and a warrior in the act of striking her with his club, his chief springing forward and arresting the blow with his spear.

QUAPAWS.

69.

KI-HIC-CA-TE-DAH, or PASSING CHIEF.

(Painted 1843.)

Principal Chief of the Quapaws. Once a very powerful and warlike tribe, but now reduced to a small number; they reside with the Senecas. This chief is represented by the agent as being a very good man, and possesses the entire confidence of his whole people.

IOWAS.

70.

WO-HUM-PA, an IOWA CHIEF, and the ARTIST.

(Painted 1843.)

It was with much difficulty that I induced this chief to sit for his portrait. I was anxious to paint one of his warriors upon the same canvas with him; to this he objected, saying that they were *no good*, and that chiefs only were worthy of such a distinguished honour;

he insisted on being painted in the act of shaking hands with me, so that when the Great Father (the President of the U. S.) saw it, he might know that he was a friend of the white man. He is a great warrior, his arms bearing evidence of this fact, having been pierced with balls and arrows in several places from the hands of the Sioux. He was very particular as to the correct imitation of the painting on his blanket, which is to him the history of his war exploits. The hands represent the scalps taken from the heads of his enemies. I tried repeatedly to get some of his warriors to sit, but they could not be induced to do it without the consent of their chief. Such was their fear of him, that they dared not enter my studio while he was present without his invitation.

WICHETAWS, OR PAWNEE PICTS.

THIS tribe live on the head-waters of Red River; are similar in their manners and customs to the Wacoes, Caddoes, and Comanches; they live in villages and raise some corn, but depend mostly upon the chase for their subsistence. They are a small tribe, numbering about three hundred warriors, are extremely poor, and use the bow and spear, having no fire-arms among them.

71.

KA-SA-ROO-KA, OR ROARING THUNDER.

(Painted 1842.)

Principal Chief of the Wichetaws or Pawnee Picts. This chief, together with his brother, visited the Cherokee Nation in the fall of 1842, and remained until after the close of the International Council in June, 1843. During his stay he spent his time with John Ross, the Principal Chief; he spoke no English, and having no interpreter, he manifested all his wants by signs. He was treated with the utmost kindness and friendship by Mr. Ross, to whom he became very much attached. He is painted as he appeared on the morning after his arrival at Fort Gibson from the prairies.

72.

NASH-TAW, or THE PAINTER.

(Painted 1842.)

Second Chief of the Wichetaws or Pawnee Picts, and a brother of Ka-sa-roo-ka.

73.

RIT-SA-AH-RESCAT, or THE WOMAN OF THE HUNT, and BRACES or BABY.

(Painted 1842.)

Wife of Nashtaw, and Child. On the arrival of the two chiefs and this woman at Fort Gibson, I took them to my studio for the purpose of painting their portraits. They very willingly acceded to my wishes, and manifested by signs that they wanted something to eat. I accordingly had as much meat cooked as would appease the appetite of six men, which they ate in a short time, and then asked for more. I again procured about the same quantity, which, to my astonishment, they also devoured. It was the first meat they had eaten for some five or six days.

They remained one day with me, and then took their departure for Mr. Ross's.

CADDOES.

THE Caddoes are one of the many small tribes residing on the western borders of Texas.

74.

BIN-TAH, THE WOUNDED MAN.

(Painted 1843.)

Principal Chief of the Caddoes. He derived his name from the fact of his having been wounded in the breast by an Osage; he wears a piece of silver suspended from his nose, as an ornament.

75.

AH-DE-BAH, OR THE TALL MAN

(Painted 1843.)

Second or Assistant Chief of the Caddoes. Painted in the act of striking the drum.

76.

SE-HIA-AH-DI-YOU, THE SINGING BIRD.

(Painted June, 1843.)

Wife of Ah-de-bah, seated in her tent. A view on Tiwoccany Creek, Texas.

77.

HA-DOON-COTE-SAH.

(Painted 1843.)

A Caddo Warrior.

ANANDARKOES.

78.

JOSE MARIA.

(Painted 1843.)

PRINCIPAL Chief of the Anandarkoes. This chief is known to the Mexicans by the name of José Maria, and to the Caddoes as Iesh. He has fought many battles with the Texans, and was severely wounded in the breast in a skirmish with them.

WACOES.

Once a powerful tribe, living on the Brazos River, Texas.

79.

KA-KA-KATISH, or THE SHOOTING STAR.

(Painted 1843.)

Principal Chief of the Wacoes. This man is justly celebrated for his powers of oratory, being probably one of the greatest natural orators now living among the Indians. At the council held upon the River Brazos, he was the principal speaker; and by his dignity and grace of manner succeeded in gaining the attention and respect of these wild and untutored sons of the forest, whose implicit confidence he enjoys.

The following is a copy of the speech made by him on that occasion :—

"Brothers: I am very glad to hear that we have all met here in friendship to-day. Amidst this assemblage I do not wish to utter falsehoods, and I believe that my Texan friend has spoken nothing but the truth. The soil I now stand upon was once mine; it is now the land of the Texans, and my home is far off in the west. I am now here on this soil, where in my young days I hunted the buffalo and red deer in peace, and was friendly with all, until the Texan came and drove me from my native land. I speak the truth—I wish for peace that shall last so long as the sun rises and sets, and the rivers flow. The wild-fire of war has swept over the land, and enveloped my home and people in smoke; but when I return and tell them what I have heard, the smoke will be dissipated, and they can find their way to the council-ground of our white brothers of Texas, and combine to quench this fire that heats our blood and impels us on to war. It made my heart glad to hear my Texan brother say, that lands and countries would be given the red men for homes, and that liberty should be granted for the red men to hunt the wild game in the forest. The chiefs of all tribes who dwell with me, and far beyond, shall hear of the true words you have spoken, and they cannot fail to be pleased. I will bear your words to the north, this

great captain to the east, and my Texan friend can bear the glad tidings to the south.

"I have nothing else to say; but I do implore the Great Spirit to bear witness that it is my fond wish that war and trouble for ever cease between us."

NATCHITOCHES.

80.

CHO-WEE, OR THE BOW.

(Painted 1843.)

PRINCIPAL Chief of the Natchitoches. This man had a brother killed by the Texans, some four or five years since, while on a hunting expedition, whose death he afterwards avenged by taking the scalps of six Texans.

TOWOCCONIES.

81.

KEECHE-KA-ROOKI, OR THE MAN WHO WAS NAMED BY THE GREAT SPIRIT.

(Painted 1844.)

PRINCIPAL Chief of the Towocconies, and acknowledged Chief of the allied tribes of Texas.

82.

KO-RAK-KOO-KISS.

(Painted 1844.)

A Towoccono Warrior. This man distinguished himself among his people by a daring attempt at stealing horses, in the night, from Fort Milan, on the western frontier of Texas. He succeeded in passing the sentries, and had secured some eight or ten horses to a lariat, and was making his way to the gates of the fort, when he was discovered and fired upon. The night being dark, the shots were at random; he was, however, severely wounded by two balls, received two sabre wounds upon his arms, and narrowly escaped with his life. He is about twenty-three years of age, and by this daring feat has won the name and standing of a warrior among his people.

KEECHIES.

83.

KO-RAN-TE-TE-DAH, or THE WOMAN WHO CATCHES THE SPOTTED FAWN.

(Painted 1844.)

A Keechie Woman, wife of Ko-rah-koo-kiss.

84.

KOT-TAN-TEEK.

(Painted 1844.)

Principal Chief of the Keechies.

85.

A BUFFALO HUNT.

(Painted 1845.)

On the South-western Prairies.

COMANCHES.

A POWERFUL and warlike tribe, divided into twenty different bands. They are migratory in their habits, subsisting upon buffalo and other game, with which their country abounds.

86.

POO-CHON-E-QUAH-EEP, OR BUFFALO-HUMP.

(Painted 1844.)

Second Chief of the Hoesh Band of Comanches, and head war-chief of all the Comanches. This chief was painted at a council of the wild Indians on the head-waters of Red River. The principal chief was in mourning for the loss of a son, and was unable to attend the council, and sent this chief with the following "talk:"—

Poo-chon-e-quah-eep stated in council, that he had been sent in by Pa-ha-eu-ka, who had spoken to him thus:—"It has pleased the Great Spirit to visit me with sorrow and trouble—I mourn the loss of my only boy, who met his death in the war-path. I must cry and mourn till green grass grows; I have burnt my lodges, killed my mules and horses, and scattered ashes on my head. I can do nothing during the season of my grief; but you, my chief, (addressing Poo-chon-e-quah-eep,) I send you afar off to meet in council the captain from the white nations of the east. You must make peace with all nations and tribes, for I am sick of hearing the cry of my people mourning the loss of some relative killed in battle. Should you meet any captain from Texas, tell him that we have heard that the people of Texas believe that we still hold many prisoners taken from their country; but such is not the case, there is but one, and he, a young man, has been raised among us from his infancy, and is now absent on a war-party against the Spaniards. If they believe not this statement, they have permission to come among us and examine for themselves; and they shall come and go freely, safely, and unmolested. We have waned, waned, and waned beyond the memory of our grandsires. We now desire to be at peace with all mankind. We want permission to travel among the white settlements in the east to learn

the white man's method of planting corn, and also to seek for some of our people whom we have lost. I want the chiefs and headmen of all nations and tribes to hear my talk and know that it is a good one. I want you, my chief, to make peace with all nations, a peace that will continue as long as there is ground for us to walk upon."

87.

PO-CHON-NAH-SHON-NOC-CO, OR THE EATER OF THE BLACK BUFFALO HEART.

(Painted 1844.)

One of the principal warriors of the Hoesh Band, or Honey-Eaters.

88.

WIFE OF PO-CHON-NAH-SHON-NOC-CO.

(Painted 1844.)

89.

O-HAH-AH-WAH-KEE, THE YELLOW PAINT HUNTER.

(Painted 1844.)

Head Chief of the Ta-nah-wee Band of Comanches.

90.

NAH-MOO-SU-KAH.

(Painted 1844.)

Comanche Mother and Child.

91.

A COMANCHE DOMESTIC SCENE.

(Painted 1844.)

A Sleeping Warrior. Landscape on the head-waters of Red River.

92.

A COMANCHE GAME.

(Painted 1844.)

This game is played exclusively by the women. They hold in their hand twelve sticks about six inches in length, which they drop upon a rock; the sticks that fall across each other are counted for game: one hundred such counts the game. They become very much excited, and frequently bet all the dressed deer-skins and buffalo-robes they possess.

PUEBLOS.

History of the "Pueblos of San Diego de Tesuque," and their customs—written by their present chief:—

"The origin and antiquity of the country and of our first ancestors date many ages back. We are wholly ignorant of the year and the time past by which to regulate the history correctly, nor is my ability sufficient to give information of a nation so ancient.

"Without doubt, this nation from its beginning was called Tegua. It was a rude, infidel nation, without religion—idolatrous, and without the observance of any worship; but their customs were extremely good and agreeable to the inhabitants of this Pueblo.

"They were governed by the cacique and a war captain, and other principal men of the Pueblo. So good were the customs which they themselves had chosen and established for the common-weal, and which they loved and embraced rigorously, and with much pleasure, that all were happy. Their crops were in abundance, all their goods in common, and they were favoured by the Almighty with union and good conduct.

"They lived under the rule of their magistrates and chiefs from among themselves, during the first conquest. At that time they knew religion, and were Catholics. In a short time the Spaniards were driven from the country to their own land by the Indians,

and in a few years came the second conquest, which remains permanent to this time.

"During the preceding years they were held in dislike by their conquerors. All the Indians of the country were under arms, and despised and persecuted by the Spaniards.

"This nation was so warlike that the Spaniards did not find any action conclusive, till a man of much force, and possessing the endurance of a nation which had passed through many troubles, appeared in all the manliness and energy of character that can be imagined. The gentleman mentioned was a native of the Pueblo of San Diego de Tesuque—his name is Don Domingo Romeo. This great man established a peace with the Spaniards for his people—a peace wise and eternal. As to the other Pueblos, they again took arms against the Spaniards: this Pueblo was not seduced by the other Pueblos."

93.

JOSE MARIA VIGIL ZUAZO.

(Painted 1852.)

94.

CARLOS VIGIL, EX-GOVERNOR OF PUEBLO.

(Painted 1852.)

95.

JUAN ANTONIO VIGIL.

(Painted 1852.)

96.

JOSE AHAYEA.

(Painted 1852.)

97.

JOSE DOMINGO HERURA.

(Painted 1852.)

APACHES.

THIS predatory tribe have no fixed home, but roam over a large extent of mountainous country that divides the waters of the Del Norte from the waters flowing into the Pacific. Game is scarce, and they gain their subsistence by plundering the settlements of Sonora, Chihuahua, and other lesser towns in the Del Norte valley—whence they supply themselves with large herds of cattle, and choice horses, which enable them to retreat with rapidity and safety.

98.

BLACK KNIFE.

(Painted 1846.)

An Apache Chief, reconnoitring the command of General Kearney on his march from Santa Fe to California.

99.

VIEW ON THE GILA RIVER.

(Painted 1851.)

"About two miles from camp, our course was traversed by a seam of yellowish-coloured igneous rock, shooting up into irregular spires and turrets, one or two thousand feet in height. It ran at right angles to the river, and extended to the north and south, in a chain of mountains, as far as the eye could reach.

"One of these towers was capped with a substance many hundred feet thick, disposed in horizontal strata of different colours, from deep red to light yellow. Partially disintegrated, and lying at the foot of the chain of spires, was a yellowish calcareous sandstone, altered by fire, in large amorphous masses. In one view could be seen clustered the Larrea Mexicana, the Cactus, (King) Cactus, (Chandelier) Greenwood Acacia, Chamiza, Prosopis Odorata, and a new variety of Sedge."

"For a better description of the Landscape, see the Sketch by Mr. Stanley."—*Lieut.-Col. W. Emory's Report to the Secretary of War.*

PIMOS.

The Pimos reside on the Gila, about ninety miles from its confluence with the Rio Colorado, and subsist chiefly by agriculture. They manufacture an excellent article of blanket from cotton, which they cultivate, and which constitutes their only article of dress.

100.

PIMO CHIEF.

(Painted 1846.)

101.

PIMO SQUAW.

(Painted 1846.)

MARICOPAS.

This tribe also resides on the Gila, to the west of the Pimo villages.

102.

MARICOPA CHIEF AND INTERPRETER.

(Painted 1846.)

SHASTE.

This tribe reside west of the Rocky Mountains, and are of the wildest of the Oregon Tribes.

103.

SHASTE SQUAW.

(Painted 1847.)

A slave to the Clackamus Indians.

UMPQUAHS.

THIS tribe reside in the valley of the Umpquah River, in the southern part of Oregon. Their country abounds in game, upon which they subsist.

104.

ENAH-TE, OR WOLF.

(Painted 1848.)

A young Warrior.

KLAMETHS.

A ROVING band of Indians, subsisting chiefly upon game. Their country is contiguous to that of the Umpquahs.

105.

TE-TO-KA-NIM.

(Painted 1848.)

Klameth Chief.

106.

ENISH-NIM.

(Painted 1848.)

Wife of Te-to-ka-nim.

CALLAPOOYAS.

This tribe formerly resided in the southern part of the Willamette valley. They are now reduced to a few in number, and have no fixed home.

107.

YELSTO.

(Painted 1848.)

A Callapooya.

CHINOOKS.

This once powerful nation reside in the vicinity of Astoria, Oregon Territory. They are few in number, and gain their subsistence by fishing.

108.

STOMAQUEA.

(Painted 1848.)

Principal chief of the Chinooks.

109.

TEL-AL-LEK.

(Painted 1848.)

Chinook Squaw.

CLACKAMUS.

This degraded remnant of a once numerous tribe reside on the Clackamus River, near Oregon City.

110.

QUATYKEN.

(Painted 1847.)

111.

DR. JOHN McLAUGHLIN.

(Painted 1848.)

Former Chief Factor of the Hon. Hudson's Bay Company, and founder of Oregon City.

112.

GOV. P. S. OGDEN.

(Painted 1848.)

Hon. Hudson's Bay Company, Oregon.

113.

OREGON CITY.

(Painted 1848.)

WILLAMETTE FALLS INDIANS.

114.

WA-SHA-MUS.

(Painted 1847.)

Principal Chief of the Willamette Falls Indians. This once

numerous band is now reduced to some half-dozen lodges, and con fined to a few barren acres of ground on the west bank of the Willamette, where they maintain a miserable existence by fishing at the falls of that river.

Although reduced in circumstances and degraded by dissipation, Wa-sha-mus retains much of that native dignity which gave him the ascendency over a brave band of warriors.

In the days of his prosperity he made frequent excursions to the mountain tribes, with whom he carried on an extensive traffic in the exchange of dried salmon for slaves, horses, dried meat, and articles of clothing or ornament. On his return from one of these excursions, he was attacked by a large party of Roque River Indians, and in the skirmish lost his left eye by an arrow. In this battle he took many scalps, which he presented to the commander of one of Her Majesty's ships, and received in return a naval officer's suit, a part of which he still retains; and when intoxicated, he may be seen in the mixed costume of an English admiral and Indian chief.

It is a very common practice of the Shaste, Umpqua, and Roque River Indians, to sell their children in slavery to the tribes inhabiting the banks of the Columbia River. During my tour through the Willamette valley in 1848, I met a party of Tlickitacks returning from one of these trading excursions, having about twenty little boys, whom they had purchased from the Umpqua tribe.

115.

MARY AND ACHATA.

(Painted 1847.)

Willamette Falls Squaws. This group belong to the great family of Chinooks, or Flat-Heads.

116.

WILLAMETTE FALLS.

(Painted 1848.)

TLICKITACKS.

117.

CASINO.

(Painted 1848.)

This chief is one of the Tlickitack Tribe, and the principal chief of all the Indians inhabiting the Columbia River, from Astoria to the Cascades. In the plenitude of his power he travelled in great state, and was often accompanied by a hundred slaves, obedient to his slightest caprice. The bands over whom he presided paid him tribute on all the furs and fish taken, as also upon the increase of their stock, to support him in this affluence.

He was the petted chief of the Hudson's Bay Company, and through him they are undoubtedly much indebted for the quiet ascendancy they always maintained over these tribes.

It is said that on visiting Fort Vancouver, his slaves often carpeted the road, from the landing to the fort, with beaver and other furs, a distance of a quarter of a mile; and that on his return, the officers of the Hudson Bay Company would take the furs, and carpet the same distance with blankets and other Indian goods, as his recompense. He is now an old man, having outlived his prosperity and posterity, to see a once numerous people reduced to a few scattered lodges, which must soon disappear before the rapidly growing settlements of the adventurous pioneers.

WALLA-WALLAS.

They reside on the Walla-Walla River, in the northern part of Oregon, and subsist chiefly upon salmon, with which their streams abound.

118.

PEO-PEO-MUX-MUX, OR YELLOW SERPENT.

(Painted 1847.)

Principal Chief of the Walla-Wallas, commonly called by the Hudson's Bay Company, Serpent Jaune.

There are many incidents of thrilling interest in this man's life, one of which will serve to show his cool, determined courage.

In the year 1841, his eldest and favourite son, of twenty-two years, had some difficulty with one of the clerks of the Hudson Bay Company, which terminated in a hand-to-hand fight. The young chief coming off second best, carried, with the tale of his inglorious exploit, a pair of black eyes to his father's lodge. The chief's dignity was insulted, and the son's honour lost, unless the officer in charge of the fort, Mr. Archibald McKinley, should have the offender punished.

The old chief, at the head of one hundred armed warriors, went into the fort, and demanded the person of the clerk for punishment. Mr. McKinley, not having heard of the difficulty, was taken quite by surprise, and after instituting inquiries, he found nothing to censure in the conduct of the young man. This decision, having been made known to the old chief, resulted in an animated discussion of the case. The Indians were not to be appeased, and some of the warriors attempted to seize the clerk; but being a powerful and athletic man, he defended himself until Mr. McKinley gave him a pistol, reserving two for himself, and charging him not to fire until he should give the word. The crisis was now at hand—the war-cry was sounded, and the savages had raised their weapons to spill the white man's blood. Mr. McKinley rushed into an adjoining room, and seizing a keg of powder, placed it in the centre of the floor, stood over it with flint and steel raised, and exclaimed that they were all brave men, and would die together. The result was the immediate flight of all the Indians, save the old chief and his son.

As soon as the warriors had gained the outer walls of the fort, the gates were closed against them; while they, halting at a respectful distance, were in momentary expectation of seeing the fort blown to atoms.

Mr. McKinley then quietly seated himself with the old chief and his son, and amicably arranged the difficulty.

CAYUSES.

The principal settlement of this nation is on the banks of a small creek flowing into the Walla-Walla River, about twenty miles from its confluence with the Columbia.

Under the superintendence of the late Dr. Whitman, (their missionary,) this nation cultivated large fields of corn, wheat, potatoes, and other vegetables, which, with the fish that annually visit the streams watering their country, enabled them to live in comparative affluence.

They also raised large stocks of cattle and horses, which they bartered to the Hudson's Bay Company for articles of European manufacture; so that they were not only above want but the wealthiest tribe in Oregon.

119.

TE-LO-KIKT, OR CRAW-FISH WALKING FORWARD.

Principal Chief of the Cayuses, and one of the principal actors in the inhuman butchery of Wailetpu. Was hung at Oregon City, June 3d, 1850.

120.

SHU-MA-HIC-CIE, OR PAINTED SHIRT.

(Painted 1847.)

One of the chief Cayuse Braves, and son of Te-lo-kíkt, and one of the active murderers of the Mission family.

After the massacre, this man was one who took a wife from the captive females—a young and beautiful girl of fourteen. In order to gain her quiet submission to his wishes, he threatened to take the life of her mother and younger sisters. Thus, in the power of savages, in a new and wild country, remote from civilization and all hope of restoration, she yielded herself to one whose hands were yet wet with the blood of an elder brother.

During the negotiations for these captives, (by Chief-factor Ogden,) and subsequent to their delivery, this man spoke with much feeling of his attachment to his white wife, and urged that she should still live with him. He said he was a great warrior, possessed many horses and cattle, and would give them all to her—or if she did not like to reside with his people, he would forsake his people, and make the country of her friends, the pale faces, his home.

121.

TUM-SUC-KEE.

Cayuse Brave. The great ringleader and first instigator of the Wailetpu massacre—was hung at Oregon city, June 3d, 1850.

122.

WAIE-CAT—ONE THAT FLIES.

Cayuse Brave and son of Tum-suc-kee. This man, though young, was an active participator in the massacre of Dr. Whitman, and committed many atrocities upon the defenceless captives. He escaped the ignominious death which awaited those not more guilty than himself.

123.

Massacre of Dr. Whitman's family at the Wailetpu Mission, in Oregon, 29th of November, 1847.

124.

Abduction of Miss Bewley from Dr. Whitman's mission.

125.

CASCADES OF THE COLUMBIA RIVER.

126.

SALMON FISHERY ON THE HEAD-WATERS OF THE COLUMBIA.

127.

MOUNT HOOD.—(OREGON.)

NEZ PERCES.

This tribe occupies the country on the head waters of Snake River. They are numerous and warlike.

128.

TIN-TIN-METZE.

(Painted 1847.)

A Nez Percé Chief.

PELOUSES.

A small band occupying the valley of the Pelouse, near its confluence with Snake River.

129.

KEOK-SOES-TEE.

(Painted 1847.)

A Pelouse Brave.

130.

VIEW ON THE PELOUSE RIVER.

131.

PELOUSE FALLS.

This beautiful cascade is situated about nine miles from the junction of the Pelouse with Snake River, and is estimated at three hundred feet in height. According to an old tradition, the Great Spirit caused this barrier to rise, to prevent the salmon from passing to a band of Indians living on its head-waters, with whom he was displeased.

132.

VIEW IN THE CASCADE MOUNTAINS.

133.

VIEW ON THE COLUMBIA.

134.

VIEW ON THE COLUMBIA.

135.

THE ARTIST TRAVELLING IN NORTHERN OREGON IN THE MONTH OF DECEMBER.

136.

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137.

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138.

THE GREAT DALLES BASIN, AND VIEW OF MOUNT HOOD.

SPOKANES.

Reside on the Spokane River, and occupy the country on the Columbia River as high as the 49° of latitude.

They subsist chiefly on salmon, which are caught in great abundance during the fishing season, and dried for winter consumption. Owing to a scarcity of game, and their improvidence, they are frequently reduced to great want, and exist for months on moss and roots. Small parties join the Flat Heads, and the Cœur-de-Lions, (who occupy the adjacent territory,) in their buffalo-hunts on the side of the Rocky Mountains.

139.

SE-LIM-COOM-CLU-LOCK, or RAVEN CHIEF.

(Painted 1847.)

Commonly called Ugly Head. Principal Chief of the Spokanes, or Flat-Heads, residing on the waters of the Spokane River. When about to commence the painting of this portrait, the old chief made a sign for me to stop, as he wished to give me a talk. He spoke near an hour, and said that his people had always been friendly with the whites—that some of the first "*long knives*" that came to his country had taken wives from among his women, and had lived among them—they were his brothers—he had adopted the white man's religion, and had used his influence to promote Christianity among his people. Shortly after the butchery at the Wailetpu Mission, a rumour reached the Spokanes that the Cayuses were coming to murder the families of Messrs. Walker and Eels, missionaries located among them at Fishimakine. The old chief collected his people, and with their lodges surrounded the mission, declaring the Cayuses should first murder them. In the mean time, Messrs. Walker and Eels prepared themselves, by barricading their houses, to resist the fate of their colabourers to the last extremity. At this exciting moment, a report reached the Spokanes, that a number of their people residing in the Willamette valley had been killed by the Americans, in retaliation for the Wailetpu massacre. The young warriors collected for the purpose of protecting Messrs. Walker and Eels from the hands of the murderous Cayuses, now became clamorous, and were with great difficulty restrained from spilling their blood themselves. The old chief told them the rumour might be false; and, by his influence and good sense, the lives of these pious labourers in the cause of Christianity were spared.

Messrs. Walker and Eels were subsequently taken from the mission to Fort Colville by the old chief, fearing the responsibility of protecting them from the Cayuses and his own impetuous warriors, if the rumoured death of their friends in the Willamette should prove true. After remaining some weeks at Fort Colville, they were taken by a company of Oregon volunteers to the settlements, where they still reside.

140.

KWIT-TEAL-CO-KOO-SUM.

(Painted 1847.)

Big Star Chief, a Medicine-man of the Spokanes. Whenever a person is sick, this tribe suppose that the spirit has left the body, and hovers invisibly in the air, until it can be charmed or brought back through the agency of the medicine-man. To accomplish this end, the patient is placed in a sitting posture, enveloped in a buffalo-robe, or other covering, having only the top of the head exposed.

The medicine-man then commences dancing and singing around the patient, gesticulating mysteriously, and often clutching in the air with his hands, as if in the act of catching something. The spirit is supposed to be attracted by the chant, and to hover near the aperture at the top of the lodge; and the dance is often continued for an hour before it can be caught. It is then pressed and rubbed, as the medicine-man pretends, through the patient's skull, whose recovery, if not soon effected, he supposes to be thwarted by his having caught the spirit of some other person; and it then becomes necessary to undo his work by setting it at liberty, and repeating the performance until the right spirit is caught.

During my stay among this people much sickness prevailed, and I was often kept awake all night by the wild chant and monotonous drum.

This chief has four wives, whom he supports in Indian affluence by the successful practice of his art of conjuration. He possesses a countenance of great intelligence, and seemed to doubt my ability to transfer it correctly to the canvas. But the picture proved to be highly satisfactory, and he became my daily visitor, and acknowledged me to be "big medicine."

141.

KAI-MISH-KON, OR MARKED HEAD.

Spokane Chief.

142.

KAI-ME-TE-KIN, OR MARKED BACK.

Spokane Brave.

143.

PA-SE-LIX.

Spokane Squaw.

144.

TIN-TIN-MA-LI-KIN, or STRONG BREAST.

STONY ISLAND INDIANS.

Reside in the vicinity of Fort Okanagan, Upper Columbia River, and subsist by fishing.

145.

HI-UP-EKAN.

Stony Island Brave.

146.

LAH-KIES-TUM.

Stony Island Squaw.

147.

SO-HA-PE.

Stony Island Brave.

OKANAGANS.

148.

WAH-PUXE.

Chief of the Priest's Rapid.

149.

KO-MAL-KAN, or LONG HAIR.

An Okanagan Medicine-man.

150.

SIN-PAH-SOX-TIN.

Okanagan Squaw.

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Painted by A. B. Moore, 1851.

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THE END.

STEREOTYPED BY L. JOHNSON & CO.
PHILADELPHIA.

SMITHSONIAN MISCELLANEOUS COLLECTIONS.

CATALOGUE

OF

NORTH AMERICAN BIRDS,

CHIEFLY IN THE MUSEUM OF THE

SMITHSONIAN INSTITUTION.

BY

SPENCER F. BAIRD.

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INTRODUCTION.

The present "Catalogue of North American Birds" has been reprinted, with some changes, from the one in quarto, forming a portion of the report on North American Birds, in Vol. IX. of the Reports of the Pacific Railroad Survey, and published as a separate paper, by the Institution, in October, 1858. Its object is to facilitate the labelling of the specimens of birds and eggs in the Museum of the Institution, as also to serve the purposes of a check list of the species.

Copies printed on one side of the paper only, for labelling, or on both sides, for miscellaneous purposes, will be furnished to institutions and individuals on application.

JOSEPH HENRY,
Secretary S. I.

1. CATHARTES AURA, Illig.

Turkey Buzzard.

2. CATHARTES CALIFORNIANUS, Cuv.

California Vulture.

3. CATHARTES ATRATUS, Lesson.

Black Vulture.

4. CATHARTES BURROVIANUS, Cassin.

Mexican Vulture.

5. FALCO ANATUM, Bonaparte.

Duck Hawk.

6. FALCO NIGRICEPS, Cassin.

Black Capped Hawk.

7. HYPOTRIORCHIS COLUMBARIUS, Gr.

Pigeon Hawk.

8. HYPOTRIORCHIS AURANTIUS, Kaup.

Orange-breasted Hawk.

9. HYPOTRIORCHIS FEMORALIS, Gray.

Aplomado.

10. FALCO POLYAGRUS, Cassin.

Prairie Falcon.

11. FALCO CANDICANS, Gmelin.

Jer Falcon.

12. FALCO ISLANDICUS, Sabine.

Jer Falcon.

13. TINNUNCULUS SPARVERIUS, Vieill.

Sparrow Hawk.

14. ASTUR ATRICAPILLUS, Bonap.

Goshawk.

15. ACCIPITER COOPERII, Bonap.

Cooper's Hawk.

16. ACCIPITER MEXICANUS, Swains.

Blue-backed Hawk.

17. ACCIPITER FUSCUS, Bonap.

Sharp-shinned Hawk.

18. BUTEO SWAINSONI, Bonap.

Swainson's Hawk.

19. BUTEO BAIRDII, Hoy.

Baird's Hawk.

20. BUTEO CALURUS, Cassin.

Black Red-tail.

21. BUTEO INSIGNATUS, Cassin.

Brown Hawk.

22. BUTEO HARLANI, Bonaparte.

Harlan's Hawk.

23. BUTEO BOREALIS, Vieill.

Red-tailed Hawk.

24. BUTEO MONTANUS, Nuttall.

Western Red-tail.

25. BUTEO LINEATUS, Jardine.

Red-shouldered Hawk.

26. BUTEO ELEGANS, Cassin.

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27. BUTEO PENNSYLVANICUS, Bonap.

Broad-winged Hawk.

28. BUTEO OXYPTERUS, Cassin.

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29. BUTEO COOPERI, Cassin.

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37. ROSTRHAMUS SOCIABILIS, D'Orb

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48. BUBO VIRGINIANUS, Bonap.

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49. SCOPS ASIO, Bonap.

Mottled Owl.

50. SCOPS McCALLII, Cassin.

Western Mottled Owl.

51. OTUS WILSONIANUS, Lesson.

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52. BRACHYOTUS CASSINII, Brewer.

Short-Eared Owl.

53. SYRNIUM CINEREUM, Aud.

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54. SYRNIUM NEBULOSUM, Gray.

Barred Owl.

55. NYCTALE RICHARDSONII, Bonap.

Sparrow Owl.

56. NYCTALE ALBIFRONS, Cassin.

Kirtland's Owl.

57. NYCTALE ACADICA, Bon.

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58. ATHENE HYPUGAEA, Bonap.

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75. PICUS HARRISII, Aud.

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77. PICUS GAIRDNERI, Aud.

Gairdner's Woodpecker.

78. PICUS NUTTALLI, Gambel.

Nuttall's Woodpecker.

79. PICUS SCALARIS, Wagler.

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80. PICUS BOREALIS, Vieill.

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81. PICUS ALBOLARVATUS, Baird.

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82. PICOIDES ARCTICUS, Gray.

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Yellow-bellied Woodpecker.

86. SPHYROPICUS NUCHALIS, Baird

Red-throated Woodpecker.

87. SPHYROPICUS RUBER, Baird.

Red-breasted Woodpecker.

88. SPHYROPICUS WILLIAMSONII, Baird.

Williamson's Woodpecker.

89. SPHYROPICUS THYROIDEUS, Baird.

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90. HYLOTOMUS PILEATUS, Baird.

Black Woodpecker.

91. CENTURUS CAROLINUS, Bonap.

Red-bellied Woodpecker.

92. CENTURUS FLAVIVENTRIS, Sw.

Yellow-bellied Woodpecker.

93. CENTURUS UROPYGIALIS, Baird.

Gila Woodpecker.

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Red-headed Woodpecker.

95. MELANERPES FORMICIVORUS, Bonap.

California Woodpecker.

96. MELANERPES TORQUATUS, Bonap.

Lewis's Woodpecker.

97. COLAPTES AURATUS, Swainson.

Yellow-shafted Flicker.

98. COLAPTES MEXICANUS, Swains.

Red-shafted Flicker.

98*a*. COLAPTES HYBRIDUS, Baird.

Hybrid Woodpecker.

99. COLAPTES CHRYSOIDES, Baird.

100. LAMPORNIS MANGO, Swains.

Mango Humming Bird.

101. TROCHILUS COLUBRIS, Linn.

Humming Bird.

102. TROCHILUS ALEXANDRI, Bourc. & Muls.

Black-chinned Humming Bird.

103. SELASPHORUS RUFUS, Sw.

Rufous Humming Bird.

104. SELASPHORUS PLATYCERCUS, Gould.

Broad-tailed Humming Bird.

105. ATTHIS ANNA, Reichenb.

Anna Humming Bird.

106. ATTHIS COSTAE, Reichenb.

Ruffed Humming Bird.

107. PANYPTILA MELANOLEUCA, Baird.

White-throated Swift.

108. NEPHOECETES NIGER, Baird.

Black Swift.

109. CHAETURA PELASGIA, Steph.

Chimney Swallow.

110. CHAETURA VAUXII, De Kay.

Oregon Swift.

111. ANTROSTOMUS CAROLINENSIS, Gould.

Chuck-will's-widow.

112. ANTROSTOMUS VOCIFERUS, Bonap.

Whip-poor-will.

113. ANTROSTOMUS NUTTALLI, Cassin.

Poor-will.

114. CHORDEILES POPETUE, Baird.

Night Hawk.

115. CHORDEILES HENRYI, Cassin.

Western Night Hawk.

116. CHORDEILES TEXENSIS, Lawrence.

Texas Night Hawk.

116*a*. NYCTIDROMUS

Pauraque.

117. CERYLE ALCYON, Boie

Belted King-fisher.

118. CERYLE AMERICANA, Boie.

Texas King-fisher.

119. MOMOTUS CAERULICEPS, Gould.

Saw-bill.

120. PACHYRHAMPHUS AGLAIAE, Lafresn.

Rose-throated Flycatcher.

121. BATHMIDURUS MAJOR, Cab.

Thick-bill.

122. MILVULUS TYRANNUS, Bonap.

Fork-tailed Flycatcher.

123. MILVULUS FORFICATUS, Sw.

Scissor-tail.

124. TYRANNUS CAROLINENSIS, Baird.

King Bird; Bee Bird.

125. TYRANNUS DOMINICENSIS, Rich.

Gray King Bird.

126. TYRANNUS VERTICALIS, Say.

Arkansas Flycatcher.

127. TYRANNUS VOCIFERANS, Sw.

Cassin's Flycatcher.

128. TYRANNUS COUCHII, Baird.

Couch's Flycatcher.

129. TYRANNUS MELANCHOLICUS, Vieill.

Silent Flycatcher.

130. MYIARCHUS CRINITUS, Cab.

Great Crested Flycatcher.

131. MYIARCHUS MEXICANUS, Baird.

Ash-throated Flycatcher.

132. MYIARCHUS COOPERI, Baird.

Mexican Flycatcher.

133. MYIARCHUS LAWRENCII, Baird.

Lawrence's Flycatcher.

134. SAYORNIS NIGRICANS, Bonap.

Black Flycatcher.

135. SAYORNIS FUSCUS, Baird.

Pewee.

136. SAYORNIS SAYUS, Baird.

Say's Flycatcher.

137. CONTOPUS BOREALIS, Baird.

Olive-sided Flycatcher.

138. CONTOPUS RICHARDSONII, Baird.

Short-legged Pewee.

139. CONTOPUS VIRENS, Cab.

Wood Pewee.

140. EMPIDONAX TRAILLII, Baird.

Traill's Flycatcher.

141. EMPIDONAX PUSILLUS, Cab.

Little Flycatcher.

142. EMPIDONAX MINIMUS, Baird.

Least Flycatcher.

143. EMPIDONAX ACADICUS, Baird.

Green-crested Flycatcher.

144. EMPIDONAX FLAVIVENTRIS, Baird

Yellow-bellied Flycatcher.

144*a*. EMPIDONAX DIFFICILIS, Baird.

Western Flycatcher.

145. EMPIDONAX HAMMONDII, Baird.

Hammond's Flycatcher.

146. EMPIDONAX OBSCURUS, Baird.

Wright's Flycatcher.

147. PYROCEPHALUS RUBINEUS, Gray.

Red Flycatcher.

148. TURDUS MUSTELINUS, Gm.

Wood Thrush.

149. TURDUS PALLASI, Cab.

Hermit Thrush.

149*a*. TURDUS SILENS, Swainson.

Silent Thrush.

150. TURDUS NANUS, Aud.

Dwarf Thrush.

151. TURDUS FUSCESCENS, Stephens

Wilson's Thrush.

152. TURDUS USTULATUS, Nuttall.

Oregon Thrush.

153. TURDUS SWAINSONII, Cab.

Olive-backed Thrush.

154. TURDUS ALICIAE, Baird.

Gray-cheeked Thrush.

155. TURDUS MIGRATORIUS, Linn.

Robin.

156. TURDUS NAEVIUS, Gmelin.

Varied Thrush.

57. SAXICOLA ŒNANTHE, Bechst.

Stone Chat.

58. SIALIA SIALIS, Baird.

Blue Bird.

59. SIALIA MEXICANA, Swains.

Western Blue Bird.

60. SIALIA ARCTICA, Swains.

Rocky Mountain Blue Bird.

61. REGULUS CALENDULA, Licht.

Ruby-crowned Wren.

62. REGULUS SATRAPA, Licht.

Golden-crested Wren.

63. REGULUS CUVIERI, Aud.

Cuvier's Golden Crest.

64. HYDROBATA MEXICANA, Baird.

Water Ouzel.

65. ANTHUS LUDOVICIANUS, Licht.

Tit-lark.

66. NEOCORYS SPRAGUEII, Sclater.

Missouri Skylark.

67. MNIOTILTA VARIA, Vieill.

Black and white Creeper.

67*a*. Var. MNIOTILTA LONGIROSTRIS, Baird.

Long-billed Creeper.

68. PARULA AMERICANA, Bonap.

Blue Yellow-back.

69. PROTONOTARIA CITREA, Baird.

Prothonotary Warbler.

70. GEOTHLYPIS TRICHAS, Cab.

Maryland Yellow-throat.

71. GEOTHLYPIS VELATUS, Cab.

Gray-headed Warbler.

72. GEOTHLYPIS PHILADELPHIA, Baird.

Mourning Warbler.

173. GEOTHLYPIS MACGILLIVRAYI, Baird.

Macgillivray's Warbler.

174. OPORORNIS AGILIS, Baird.

Connecticut Warbler.

175. OPORORNIS FORMOSUS, Baird.

Kentucky Warbler.

176. ICTERIA VIRIDIS, Bonap.

Yellow-breasted Chat.

177. ICTERIA LONGICAUDA, Lawr.

Long-tailed Chat.

178. HELMITHERUS VERMIVORUS, Bonap.

Worm-eating Warbler.

179. HELMITHERUS SWAINSONII, Bonap.

Swainson's Warbler.

180. HELMINTHOPHAGA PINUS, Baird.

Blue-winged Yellow Warbler.

181. HELMINTHOPHAGA CHRYSOPTERA, B

Golden-winged Warbler.

182. HELMINTHOPHAGA BACHMANI, Cab

Bachman's Warbler

183. HELMINTHOPHAGA RUFICAPILLA, Bd.

Nashville Warbler.

183*a*. HELMINTHOPHAGA VIRGINIAE, Baird.

Mountain Warbler.

184. HELMINTHOPHAGA CELATA, Baird.

Orange-crowned Warbler.

185. HELMINTHOPHAGA PEREGRINA, Cab.

Tennessee Warbler.

186. SEIURUS AUROCAPILLUS, Sw.

Golden-crowned Thrush.

187. SEIURUS NOVEBORACENSIS, Nutt.

Water Thrush.

188. SEIURUS LUDOVICIANUS, Bonap.

Large-billed Water Thrush.

189. DENDROICA VIRENS, Baird.

Black-throated Green Warbler.

190. DENDROICA OCCIDENTALIS, Baird.

Western Warbler.

191. DENDROICA TOWNSENDII, Baird.

Townsend's Warbler.

192. DENDROICA NIGRESCENS, Baird.

Black-throated Gray Warbler.

193. DENDROICA CANADENSIS, Baird.

Black-throated Blue Warbler.

194. DENDROICA CORONATA, Gray.

Yellow-rump Warbler.

195. DENDROICA AUDUBONII, Baird.

Audubon's Warbler.

196. DENDROICA BLACKBURNIAE, Baird.

Blackburnian Warbler.

197. DENDROICA CASTANEA, Baird.

Bay-breasted Warbler.

198. DENDROICA PINUS, Baird.

Pine-creeping Warbler.

199. DENDROICA MONTANA, Baird.

Blue Mountain Warbler.

200. DENDROICA PENNSYLVANICA, Baird.

Chestnut-sided Warbler.

201. DENDROICA CAERULEA, Baird.

Blue Warbler.

202. DENDROICA STRIATA, Baird.

Black Poll Warbler.

203. DENDROICA AESTIVA, Baird.

Yellow Warbler.

204. DENDROICA MACULOSA, Baird.

Black and Yellow Warbler.

205. DENDROICA KIRTLANDII, Baird.

Kirtland's Warbler.

206. DENDROICA TIGRINA, Baird.

Cape May Warbler.

207. DENDROICA CARBONATA, Baird.

Carbonated Warbler.

208. DENDROICA PALMARUM, Baird.

Yellow Red Poll.

209. DENDROICA SUPERCILIOSA, Baird.

Yellow-throated Warbler.

210. DENDROICA DISCOLOR, Baird.

Prairie Warbler.

211. MYIODIOCTES MITRATUS, Aud.

Hooded Warbler.

212. MYIODIOCTES MINUTUS, Baird.

Small-headed Flycatcher.

213. MYIODIOCTES PUSILLUS, Bonap.

Green Black-cap Flycatcher.

214. MYIODIOCTES CANADENSIS, Aud.

Canada Flycatcher.

215. MYIODIOCTES BONAPARTII, Aud.

Bonaparte's Flycatcher.

216. CARDELLINA RUBRA, Bonap.

Vermilion Flycatcher.

217. SETOPHAGA RUTICILLA, Sw.

Redstart.

218. SETOPHAGA PICTA, Sw.

Painted Flycatcher.

219. SETOPHAGA MINIATA, Sw.

Red-bellied Flycatcher.

220. PYRANGA RUBRA, Vieill.

Scarlet Tanager.

221. PYRANGA AESTIVA, Vieill.

Summer Red Bird.

222. PYRANGA HEPATICA, Swains.

Rocky Mountain Tanager.

223. PYRANGA LUDOVICIANA, Bonap.

Louisiana Tanager.

224. EUPHONIA ELEGANTISSIMA, Gray.

Blue-headed Tanager.

225. HIRUNDO HORREORUM, Barton.

Barn Swallow.

226. HIRUNDO LUNIFRONS, Say.

Cliff Swallow.

227. HIRUNDO BICOLOR, Vieill.

White-bellied Swallow.

228. HIRUNDO THALASSINA, Sw.

Violet Green Swallow.

229. COTYLE RIPARIA, Boie.

Bank Swallow.

230. COTYLE SERRIPENNIS, Bonap.

Rough-winged Swallow.

231. PROGNE PURPUREA, Boie.

Purple Martin.

231*a*. PROGNE ——

(Florida.)

232. AMPELIS GARRULUS, Linn.

Wax Wing.

233. AMPELIS CEDRORUM, Baird.

Cedar Bird.

234. PHAINOPEPLA NITENS, SCLATER.

Black-crested Flycatcher.

235. MYIADESTES TOWNSENDII, CAB.

Townsend's Flycatcher.

236. COLLYRIO BOREALIS, BAIRD.

Great Northern Shrike.

237. COLLYRIO LUDOVICIANUS, BAIRD.

Loggerhead Shrike.

238. COLLYRIO EXCUBITOROIDES, BAIRD.

White-rumped Shrike.

239. COLLYRIO ELEGANS, BAIRD.

White-winged Shrike.

240. VIREO OLIVACEUS, VIEILL.

Red-eyed Flycatcher.

241. VIREO FLAVOVIRIDIS, CASSIN.

Yellow-green Vireo.

242. VIREO VIRESCENS, VIEILL.

Bartram's Vireo.

243. VIREO ALTILOQUUS, GRAY.

Whip Tom Kelly.

244. VIREO PHILADELPHICUS, CASSIN.

Philadelphia Vireo.

245. VIREO GILVUS, BONAP.

Warbling Flycatcher.

246. VIREO BELLI, AUD.

Bell's Vireo.

247. VIREO ATRICAPILLUS, WOODH.

Black-headed Flycatcher.

248. VIREO NOVEBORACENSIS, BONAP.

White-eyed Vireo.

249. VIREO HUTTONI, CASS.

Hutton's Flycatcher.

250. VIREO SOLITARIUS, VIEILL.

Blue-headed Flycatcher.

251. VIREO CASSINII, XANTUS.

Cassin's Vireo.

252. VIREO FLAVIFRONS, VIEILL.

Yellow-throated Flycatcher.

253. MIMUS POLYGLOTTUS, BOIE.

Mocking Bird.

253*a*. Var. MIMUS CAUDATUS, BAIRD.

Long-tailed Mocker.

254. MIMUS CAROLINENSIS, GRAY

Cat Bird.

255. OREOSCOPTES MONTANUS, BAIRD.

Mountain Mocking Bird.

256. HARPORHYNCHUS REDIVIVUS, CAB

California Thrush.

257. HARPORHYNCHUS LECONTII, BONAP.

Leconte's Thrush.

258. HARPORHYNCHUS CRISSALIS, HENRY.

Red-vented Thrush.

259. HARPORHYNCHUS CURVIROSTRIS, CA.

Curve-billed Thrush.

259*a*. HARPORHYNCHUS VETULA, BAIRD.

Mexican Thrush.

260. HARPORHYNCHUS LONGIROSTRIS, CA.

Texas Thrasher.

261. HARPORHYNCHUS RUFUS, CAB.

Brown Thrush.

261*a*. HARPORHYNCHUS LONGICAUDA, BD

Long-tailed Thrush.

262. CAMPYLORHYNCHUS BRUNNEICAPILLUS, GRAY.

263. CATHERPES MEXICANUS, BAIRD.

White-throated Wren.

264. SALPINCTES OBSOLETUS, CAB.

Rock Wren.

265. THRYOTHORUS LUDOVICIANUS, BONAP

Great Carolina Wren.

266. THRYOTHORUS BERLANDIERI, COUCH.

Berlandier's Wren.

267. THRYOTHORUS BEWICKII, BONAP.

Bewick's Wren.

268. CISTOTHORUS PALUSTRIS, CAB.

Long-billed Marsh Wren.

269. CISTOTHORUS STELLARIS, CAB.

Short-billed Marsh Wren.

270. TROGLODYTES AEDON, VIEILL.

House Wren.

271. TROGLODYTES PARKMANNI, Aud.

Parkman's Wren.

272. TROGLODYTES AMERICANUS, Aud.

Wood Wren.

273. TROGLODYTES HYEMALIS, Vieill.

Winter Wren.

274. CHAMAEA FASCIATA, Gambel.

Ground Tit.

275. CERTHIA AMERICANA, Bonap.

American Creeper.

276. CERTHIA MEXICANA, Gloger.

Mexican Creeper.

277. SITTA CAROLINENSIS, Gmelin.

White-bellied Nuthatch.

278. SITTA ACULEATA, Cassin.

Slender-billed Nuthatch.

279. SITTA CANADENSIS, Linn

Red-bellied Nuthatch.

280. SITTA PUSILLA, Latham.

Brown-headed Nuthatch.

281. SITTA PYGMAEA, Vigors.

California Nuthatch.

282. POLIOPTILA CAERULEA, Sclat.

Blue-gray Gnatcatcher.

283. POLIOPTILA PLUMBEA, Baird.

Western Gnatcatcher.

284. POLIOPTILA MELANURA, Lawrence.

Black-tailed Gnatcatcher.

285. LOPHOPHANES BICOLOR, Bonap.

Tufted Titmouse.

286. LOPHOPHANES ATRICRISTATUS, Cass.

Black-crested Tit.

287. LOPHOPHANES INORNATUS, Cassin.

Gray Titmouse.

288. LOPHOPHANES WOLLWEBERI, Bonap.

Wollweber's Titmouse.

289. PARUS SEPTENTRIONALIS, Harris.

Long-tailed Chickadee.

289*a*. Var. PARUS ALBESCENS, Baird.

Hoary Titmouse.

290. PARUS ATRICAPILLUS, Linn.

Black-cap Titmouse.

291. PARUS OCCIDENTALIS, Baird.

Western Titmouse.

292. PARUS MERIDIONALIS, Sclater.

Mexican Titmouse.

293. PARUS CAROLINENSIS, Aud.

Carolina Titmouse.

294. PARUS MONTANUS, Gambel.

Mountain Titmouse.

295. PARUS RUFESCENS, Towns.

Chestnut-backed Tit.

296. PARUS HUDSONICUS, Forster.

Hudsonian Titmouse.

297. PSALTRIPARUS MELANOTUS, Bonap

Black-cheeked Tit.

298. PSALTRIPARUS MINIMUS, Bonap.

Least Tit.

299. PSALTRIPARUS PLUMBEUS, Baird.

Lead-colored Tit.

300. PAROIDES FLAVICEPS, Baird.

Verdin.

301. CERTHIOLA FLAVEOLA, Sund.

Yellow-rumped Creeper.

302. EREMOPHILA CORNUTA, Boie.

Sky Lark.

303. HESPERIPHONA VESPERTINA, Bonap

Evening Grosbeak.

304. PINICOLA CANADENSIS, Cab.

Pine Grosbeak.

305. CARPODACUS PURPUREUS, Gray.

Purple Finch.

306. CARPODACUS CALIFORNICUS, Baird.

Western Purple Finch.

307. CARPODACUS CASSINII, Baird.

Cassin's Purple Finch.

308. CARPODACUS FRONTALIS, Gray.

House Finch.

309. CARPODACUS HAEMORRHOUS, Wagl.

Mexican Finch.

310. CHRYSOMITRIS MAGELLANICA, Bonap.
Black-headed Goldfinch.

311. CHRYSOMITRIS STANLEYI, Bonap.
Stanley's Goldfinch.

312. CHRYSOMITRIS YARRELLI, Bonap.
Yarrell's Goldfinch.

313. CHRYSOMITRIS TRISTIS, Bonap.
Yellow Bird.

314. CHRYSOMITRIS PSALTRIA, Bonap.
Arkansas Finch.

315 CHRYSOMITRIS MEXICANA, Bonap.
Mexican Goldfinch.

316. CHRYSOMITRIS LAWRENCII, Bonap.
Lawrence's Goldfinch.

317. CHRYSOMITRIS PINUS, Bonap.
Pine Finch.

318. CURVIROSTRA AMERICANA, Wils.
Red Crossbill.

318*a*. Var. CURVIROSTRA MEXICANA, Strick.
Mexican Goldfinch.

319. CURVIROSTRA LEUCOPTERA, Wils.
White-winged Crossbill.

320. AEGIOTHUS LINARIA, Cab.
Lesser Red Poll.

321. AEGIOTHUS CANESCENS, Cab.
Mealy Red Poll.

322. LEUCOSTICTE TEPHROCOTIS, Sw.
Gray-crowned Finch.

323. LEUCOSTICTE GRISEINUCHA, Bonap.
Gray-necked Finch.

324. LEUCOSTICTE ARCTOUS, Bonap.
Arctic Finch.

325. PLECTROPHANES NIVALIS, Meyer.
Snow Bunting.

326. PLECTROPHANES LAPPONICUS, Selby.
Lapland Longspur.

327. PLECTROPHANES PICTUS, Sw.
Smith's Bunting.

328 PLECTROPHANES ORNATUS, Towns.
Chestnut-collared Bunting.

329. PLECTROPHANES MELANOMUS, Baird.
Black-shouldered Longspur.

330. PLECTROPHANES MACCOWNII, Lawr.
Maccown's Longspur.

331. CENTRONYX BAIRDII, Baird.
Baird's Bunting.

332. PASSERCULUS SAVANNA, Bonap.
Savannah Sparrow.

333. PASSERCULUS SANDWICHENSIS, Bd.
Nootka Sparrow.

334. PASSERCULUS ANTHINUS, Bonap.
Spotted Sparrow.

335. PASSERCULUS ALAUDINUS, Bonap.
Lark Sparrow.

336. PASSERCULUS ROSTRATUS, Baird.
Beaked Sparrow.

337. POOECETES GRAMINEUS, Baird.
Grass Finch.

338. COTURNICULUS PASSERINUS, Bonap.
Yellow-winged Sparrow.

339. COTURNICULUS HENSLOWI, Bonap.
Henslow's Bunting,

340. COTURNICULUS LECONTII, Bonap.
Leconte's Bunting.

341. AMMODROMUS CAUDACUTUS, Sw.
Sharp-tailed Finch.

342. AMMODROMUS MARITIMUS, Sw.
Sea-side Finch.

343. AMMODROMUS SAMUELIS, Baird.
Samuel's Finch.

344. CHONDESTES GRAMMACA, Bonap.
Lark Finch.

345. ZONOTRICHIA LEUCOPHRYS, Sw.
White-crowned Sparrow.

346. ZONOTRICHIA GAMBELII, Gambel.
Gambel's Finch.

347. ZONOTRICHIA CORONATA, Baird.
Golden-crowned Sparrow.

348. ZONOTRICHIA QUERULA, Gamb.
Harris's Finch.

349. ZONOTRICHIA ALBICOLLIS, Bonap.

White-throated Sparrow.

350. JUNCO CINEREUS, Cab.

Mexican Junco.

351 JUNCO DORSALIS, Henry.

Red-backed Snow Bird.

352. JUNCO OREGONUS, Sclat.

Oregon Snow Bird.

353. JUNCO CANICEPS, Baird.

Gray-headed Snow Bird.

354. JUNCO HYEMALIS, Sclat.

Black Snow Bird.

355. POOSPIZA BILINEATA, Sclat.

Black-throated Sparrow.

356. POOSPIZA BELLI, Sclat.

Bell's Finch.

357. SPIZELLA MONTICOLA, Baird.

Tree Sparrow.

358. SPIZELLA PUSILLA, Bonap.

Field Sparrow.

359. SPIZELLA SOCIALIS, Bonap.

Chipping Sparrow.

360. SPIZELLA PALLIDA, Bonap.

Clay-colored Bunting.

361. SPIZELLA BREWERI, Cass.

Brewer's Sparrow.

362. SPIZELLA ATRIGULARIS, Baird.

Black-chinned Sparrow.

363. MELOSPIZA MELODIA, Baird.

Song Sparrow.

364. MELOSPIZA HEERMANNI, Baird.

Heermann's Song Sparrow.

365 MELOSPIZA GOULDII, Baird.

Gould's Sparrow.

366. MELOSPIZA RUFINA, Baird.

Rusty Song Sparrow.

367. MELOSPIZA FALLAX, Baird.

Mountain Song Sparrow.

368. MELOSPIZA LINCOLNII, Baird.

Lincoln's Finch.

369. MELOSPIZA PALUSTRIS, Baird.

Swamp Sparrow.

370. PEUCAEA AESTIVALIS, Cab

Bachman's Finch.

371. PEUCAEA CASSINII, Baird.

Cassin's Finch.

372. PEUCAEA RUFICEPS, Baird.

Brown-headed Finch.

373. EMBERNAGRA RUFIVIRGATA, Lawr.

Texas Finch.

374. PASSERELLA ILIACA, Sw.

Fox-colored Sparrow.

375. PASSERELLA TOWNSENDII, Nutt.

Oregon Finch.

376. PASSERELLA SCHISTACEA, Baird.

Slate-colored Sparrow.

376*a*. PASSERELLA MEGARHYNCHUS, Bd

Thick-billed Finch.

377. CALAMOSPIZA BICOLOR, Bonap.

Lark Bunting.

378. EUSPIZA AMERICANA, Bonap.

Black-throated Bunting.

379. EUSPIZA TOWNSENDII, Bonap.

Townsend's Bunting.

380. GUIRACA LUDOVICIANA, Sw.

Rose-breasted Grosbeak.

381. GUIRACA MELANOCEPHALA, Sw.

Black-headed Grosbeak.

382. GUIRACA CAERULEA, Sw.

Blue Grosbeak.

383. CYANOSPIZA PARELLINA, Baird.

Blue Bunting.

384. CYANOSPIZA CIRIS, Baird.

Painted Bunting.

385. CYANOSPIZA VERSICOLOR, Baird.

Varied Bunting.

386. CYANOSPIZA AMOENA, Baird.

Lazuli Finch.

387. CYANOSPIZA CYANEA, Baird.

Indigo Bird.

388. SPERMOPHILA MORELETII, PUCHERAN.

Little Seedeater.

389. PYRRHULOXIA SINUATA, BONAP.

Texas Cardinal.

390. CARDINALIS VIRGINIANUS, BONAP.

Red Bird.

391 PIPILO ERYTHROPHTHALMUS, VIEILL.

Ground Robin; Towhee.

392. PIPILO OREGONUS, BELL.

Oregon Ground Robin.

393. PIPILO ARCTICUS, SW.

Arctic Towhee.

394. PIPILO MEGALONYX, BAIRD.

Spurred Towhee.

395. PIPILO ABERTII, BAIRD.

Abert's Towhee.

396. PIPILO FUSCUS, SW.

Brown Towhee.

397. PIPILO MESOLEUCUS, BAIRD.

Canon Finch.

398. PIPILO CHLORURA, BAIRD.

Green-tailed Finch.

399. DOLICHONYX ORYZIVORUS, SW.

Boblink; Reed Bird.

400. MOLOTHRUS PECORIS, SW.

Cow Bird.

401. AGELAIUS PHOENICEUS, VIEILL.

Red-winged Blackbird.

402. AGELAIUS GUBERNATOR, BONAP.

Red-shouldered Blackbird.

403. AGELAIUS TRICOLOR, BONAPARTE.

Red and White-shouldered Blackbird.

404. XANTHOCEPHALUS ICTEROCEPHAL'S

Yellow-headed Blackbird.

405. TRUPIALIS MILITARIS, BONAP.

Red-breasted Lark.

406. STURNELLA MAGNA, SW.

Meadow Lark.

407. STURNELLA NEGLECTA, AUD.

Western Lark.

408. ICTERUS VULGARIS, DAUDIN.

Troupial.

409. ICTERUS AUDUBONII, GIRAUD.

Audubon's Oriole.

410. ICTERUS MELANOCEPHALUS, GRAY

Black-headed Oriole.

411. ICTERUS PARISORUM, BONAP

Scott's Oriole.

412. ICTERUS WAGLERI, SCLATER.

Wagler's Oriole.

413. ICTERUS CUCULLATUS, SWAINS.

Hooded Oriole.

414. ICTERUS SPURIUS, BONAP.

Orchard Oriole.

415. ICTERUS BALTIMORE, DAUDIN.

Baltimore Oriole.

416. ICTERUS BULLOCKII, BONAP.

Bullock's Oriole.

417. SCOLECOPHAGUS FERRUGINEUS, SW.

Rusty Blackbird.

418. SCOLECOPHAGUS CYANOCEPHALUS.

Brewer's Blackbird.

419. QUISCALUS MACROURA, SW.

Long-tailed Grakle.

420. QUISCALUS MAJOR, VIEILL.

Boat-tailed Grakle.

421. QUISCALUS VERSICOLOR, VIEILL.

Crow Blackbird.

422. QUISCALUS BARITUS, VIEILL.

Florida Blackbird.

423. CORVUS CARNIVORUS, BARTRAM.

American Raven.

424. CORVUS CACALOTL, WAGL.

Colorado Raven.

425. CORVUS CRYPTOLEUCUS, COUCH.

White-necked Crow.

426. CORVUS AMERICANUS, AUD.

Common Crow.

427. var. CORVUS FLORIDANUS, BAIRD.

Florida Crow.

428. CORVUS CAURINUS, Baird.

Western Fish Crow.

429. CORVUS OSSIFRAGUS, Wilson.

Fish Crow.

430. PICICORVUS COLUMBIANUS, Bonap.

Clark's Crow.

431. GYMNOKITTA CYANOCEPHALA, Pr. M.

Maximilian's Jay.

432. PICA HUDSONICA, Bonap.

Magpie.

433. PICA NUTTALLI, Aud.

Yellow-billed Magpie.

434. CYANURA CRISTATA, Sw.

Blue Jay.

435. CYANURA STELLERI, Sw.

Steller's Jay.

436. CYANURA MACROLOPHUS, Baird.

Long-crested Jay.

437. CYANOCITTA CALIFORNICA, Strick.

California Jay.

438. CYANOCITTA WOODHOUSII, Baird.

Woodhouse's Jay.

439. CYANOCITTA FLORIDANA, Bonap.

Florida Jay.

440. CYANOCITTA SORDIDA, Baird.

Mountain Jay.

441. CYANOCITTA ULTRAMARINA, Strick.

Ultramarine Jay.

442. XANTHOURA LUXUOSA, Bonap.

Green Jay.

443. PERISOREUS CANADENSIS, Bonap.

Canada Jay.

444. PSILORHINUS MORIO, Gray.

Brown Jay.

445. COLUMBA FASCIATA, Say.

Band-tailed Pigeon.

446. COLUMBA FLAVIROSTRIS, Wagl.

Red-billed Dove.

447. COLUMBA LEUCOCEPHALA, Linn.

White-headed Pigeon.

448. ECTOPISTES MIGRATORIA, Sw.

Wild Pigeon.

449. ZENAIDA AMABILIS, Bonap.

Zenaida Dove.

450. MELOPELIA LEUCOPTERA, Bonap.

White-winged Dove.

451. ZENAIDURA CAROLINENSIS, Bonap

Common Dove.

452. SCARDAFELLA SQUAMOSA, Bonap.

Scaly Dove.

453. CHAMAEPELIA PASSERINA, Sw.

Ground Dove.

454. OREOPELEIA MARTINICA, Reich.

Key West Pigeon.

455. STARNOENAS CYANOCEPHALA, Bon

Blue-headed Pigeon.

456. ORTALIDA M'C CALLI, Baird.

Chiacalacca.

457. MELEAGRIS GALLOPAVO, Linn.

Wild Turkey.

458. MELEAGRIS MEXICANA, Gould.

Mexican Turkey.

459. TETRAO OBSCURUS, Say.

Dusky Grouse.

460. TETRAO CANADENSIS, Linn.

Spruce Partridge.

461. TETRAO FRANKLINII, Douglas.

Franklin's Grouse.

462. CENTROCERCUS UROPHASIANUS, Sw.

Sage Cock.

463. PEDIOECETES PHASIANELLUS, Baird

Sharp-tailed Grouse.

464. CUPIDONIA CUPIDO, Baird.

Prairie Hen.

465. BONASA UMBELLUS, Steph.

Ruffed Grouse.

465*a*. var. BONASA UMBELLOIDES, Baird.

Gray Mountain Grouse.

466. BONASA SABINII, Baird.

Oregon Grouse.

467. LAGOPUS ALBUS, Aud.

White Ptarmigan.

468. LAGOPUS RUPESTRIS, Leach.

Rock Grouse.

469. LAGOPUS LEUCURUS, Swains.

White-tailed Ptarmigan.

470. LAGOPUS AMERICANUS, Aud.

American Ptarmigan.

471. ORTYX VIRGINIANUS, Bonap.

Partridge; Quail.

472. ORTYX TEXANUS, Lawr.

Texas Quail.

473. OREORTYX PICTUS, Baird.

Mountain Quail.

474. LOPHORTYX CALIFORNICUS, Bonap.

California Quail.

475. LOPHORTYX GAMBELII, Nutt.

Gambel's Partridge.

476. CALLIPEPLA SQUAMATA, Gray.

Blue Partridge.

477. CYRTONYX MASSENA, Gould.

Massena Partridge.

478. GRUS AMERICANUS, Ord.

Whooping Crane.

479. GRUS CANADENSIS, Temm.

Sand-hill Crane.

480. GRUS FRATERCULUS, Cassin.

Little Crane.

481. ARAMUS GIGANTEUS, Baird.

Crying Bird.

482. DEMIEGRETTA PEALII, Baird.

Peale's Egret.

483. DEMIEGRETTA RUFA, Baird.

Reddish Egret.

484. DEMIEGRETTA LUDOVICIANA, Baird.

Louisiana Heron.

485. GARZETTA CANDIDISSIMA, Bonap.

Snowy Heron.

486. HERODIAS EGRETTA, Gray.

White Heron.

486*a*. HERODIAS EGRETTA, v. CALIFORNICA

California Egret.

487. ARDEA HERODIAS, Linn.

Great Blue Heron.

488. ARDEA WURDEMANNII, Baird.

Florida Heron.

489. AUDUBONIA OCCIDENTALIS, Bonap.

Great White Heron.

490. FLORIDA CAERULEA, Baird.

Blue Heron.

491. ARDETTA EXILIS, Gray.

Least Bittern.

492. BOTAURUS LENTIGINOSUS, Steph.

Bittern; Stake Driver.

493. BUTORIDES VIRESCENS, Bonap.

Green Heron.

494. BUTORIDES BRUNNESCENS, Baird.

Brown Heron.

495. NYCTIARDEA GARDENI, Baird.

Night Heron.

496. NYCTHERODIUS VIOLACEUS, Reich.

Yellow-crowned Heron.

497. TANTALUS LOCULATOR, Linn.

Wood Ibis.

498. IBIS RUBRA, Vieillot.

Red Ibis.

499. IBIS ALBA, Vieillot.

White Ibis.

500. IBIS ORDII, Bonaparte.

Glossy Ibis.

500*a*. IBIS GUARAUNA, Shaw.

Bronzed Ibis.

501. PLATALEA AJAJA, Linn.

Rosy Spoonbill.

502. PHOENICOPTERUS RUBER, Linn.

Flamingo.

503. CHARADRIUS VIRGINICUS, Borck.

Golden Plover.

504. AEGIALITIS VOCIFERUS, Cassin.

Killdeer.

505. AEGIALITIS MONTANUS, Cassin.

Mountain Plover.

506. AEGIALITIS WILSONIUS, Cassin.

Wilson's Plover.

507. AEGIALITIS SEMIPALMATUS, Cab.

Semipalmated Plover.

508. AEGIALITIS MELODUS, Cab.

Piping Plover.

509. AEGIALITIS NIVOSUS, Cassin.

Western Plover.

510. SQUATAROLA HELVETICA, Cuv.

Black-bellied Plover.

511. APHRIZA VIRGATA, Gray.

Surf Bird.

512. HAEMATOPUS PALLIATUS, Temm.

Oyster Catcher.

513. HAEMATOPUS NIGER, Pallas.

Bachman's Oyster Catcher.

514. HAEMATOPUS ATER, Vieillot.

Dusky Oyster Catcher.

515. STREPSILAS INTERPRES, Illig.

Turnstone.

516. STREPSILAS MELANOCEPHALA, Vig.

Black Turnstone.

517. RECURVIROSTRA AMERICANA, Gm.

American Avoset.

518. HIMANTOPUS NIGRICOLLIS, Vieillot.

Black-necked Stilt.

519. PHALAROPUS WILSONII, Sab.

Wilson's Phalarope.

520. PHALAROPUS HYPERBOREUS, Temm.

Northern Phalarope.

521. PHALAROPUS FULICARIUS, Bonap.

Red Phalarope.

522. PHILOHELA MINOR, Gray.

American Woodcock.

523. GALLINAGO WILSONII, Bonap.

English Snipe.

524. MACRORHAMPHUS GRISEUS, Leach.

Red-breasted Snipe.

525. MACRORHAMPHUS SCOLOPACEUS, La.

Greater Longbeak.

526. TRINGA CANUTUS, Linn.

Knot.

527 TRINGA COOPERI, Baird.

Cooper's Sandpiper.

528. TRINGA MARITIMA, Brünnich.

Purple Sandpiper.

529. TRINGA SUBARQUATA, Temm.

Curlew Sandpiper.

530. TRINGA ALPINA, var. AMERICANA, Cas.

Red-backed Sandpiper.

531. TRINGA MACULATA, Vieill.

Jack Snipe.

532. TRINGA WILSONII, Nuttall.

Least Sandpiper.

533. TRINGA BONAPARTII, Schlegel.

Bonaparte's Sandpiper.

534. CALIDRIS ARENARIA, Illiger.

Sanderling.

535. EREUNETES PETRIFICATUS, Ill.

Semipalmated Sandpiper.

536. MICROPALAMA HIMANTOPUS, Baird.

Stilt Sandpiper.

537. SYMPHEMIA SEMIPALMATA, Hartl.

Willet.

538. GLOTTIS FLORIDANUS, Bonap.

Florida Greenshank.

539. GAMBETTA MELANOLEUCA, Bonap.

Tell-tale; Stone Snipe.

540. GAMBETTA FLAVIPES, Bonap.

Yellow Legs.

541. RHYACOPHILUS SOLITARIUS, Bonap

Solitary Sandpiper.

542. HETEROSCELUS BREVIPES, Baird.

Wandering Tatler.

543. TRINGOIDES MACULARIUS, Gray.

Spotted Sandpiper.

544. PHILOMACHUS PUGNAX, Gray.

Ruff.

545. ACTITURUS BARTRAMIUS, Bonap.

Field Plover.

546. TRYNGITES RUFESCENS, Cab.

Buff-breasted Sandpiper.

547. LIMOSA FEDOA, Ord.

Marbled Godwit.

548. LIMOSA HUDSONICA, Sw.

Hudson Godwit.

549. NUMENIUS LONGIROSTRIS, Wils.

Long-billed Curlew.

550. NUMENIUS HUDSONICUS, Latham.

Hudsonian Curlew.

551. NUMENIUS BOREALIS, Latham.

Esquimaux Curlew.

552. RALLUS ELEGANS, Aud.

Marsh Hen.

553. RALLUS CREPITANS, Gm.

Clapper Rail.

554. RALLUS VIRGINIANUS, Linn.

Virginia Rail.

555. PORZANA CAROLINA, Vieill.

Common Rail.

556. PORZANA JAMAICENSIS, Cassin.

Little Black Rail.

557. PORZANA NOVEBORACENSIS,

Yellow Rail.

558. CREX PRATENSIS, Bechst.

Corn-crake.

559. FULICA AMERICANA, Gmelin.

Coot.

560. GALLINULA GALEATA, Bonap.

Florida Gallinule.

561. GALLINULA MARTINICA, Lath.

Purple Gallinule.

561*a*. CYGNUS AMERICANUS, Sharpless.

American Swan.

562. CYGNUS BUCCINATOR, Rich.

Trumpeter Swan.

563. ANSER HYPERBOREUS, Pallas.

Snow Goose.

563*a*. ANSER ALBATUS, Cassin.

White Goose.

564. ANSER CAERULESCENS, Linn.

White-headed Goose.

565. ANSER GAMBELII, Hartlaub.

White-fronted Goose.

566. ANSER FRONTALIS, Baird.

Brown-fronted Goose.

567. BERNICLA CANADENSIS, Boie.

Canada Goose.

567*a*. BERNICLA OCCIDENTALIS, Baird.

Western Goose.

568. BERNICLA LEUCOPAREIA, Cassin.

White-cheeked Goose.

569. BERNICLA HUTCHINSII, Bonap.

Hutchin's Goose.

570. BERNICLA BRENTA, Steph.

Brant.

571. BERNICLA NIGRICANS, Cassin.

Black Brant.

572. BERNICLA LEUCOPSIS, (Linn.)

Barnacle Goose.

573. CHLOEPHAGA CANAGICA, Bonap.

Painted Goose.

574. DENDROCYGNA AUTUMNALIS, Eyton

Long-legged Duck.

575. DERDROCYGNA FULVA, Burm.

Brown Tree-duck.

576. ANAS BOSCHAS, Linn.

Mallard.

577. ANAS OBSCURA, Gm.

Black Duck.

578. DAFILA ACUTA, Jenyns.

Sprig-tail; Pin-tail.

579. NETTION CAROLINENSIS, Baird

Green-winged Teal.

580. NETTION CRECCA, Kaup.

English Teal.

581. QUERQUEDULA DISCORS, Steph.

Blue-winged Teal.

582. QUERQUEDULA CYANOPTERUS, Cassin.

Red-breasted Teal.

583. SPATULA CLYPEATA, Boie.

Shoveller.

584. CHAULELASMUS STREPERUS, Gray.

Gadwall.

585. MARECA AMERICANA, Stephens

Baldpate.

586. MARECA PENELOPE, Bonap.

Widgeon.

587. AIX SPONSA, Boie.

Summer Duck.

588. FULIX MARILA, Baird.

Greater Black-head.

589. FULIX AFFINIS, Baird.

Little Black-head.

590. FULIX COLLARIS, Baird.

Ring-necked Duck.

591. AYTHYA AMERICANA, Bonap.

Red-head.

592. AYTHYA VALLISNERIA, Bonap.

Canvass-back.

593. BUCEPHALA AMERICANA, Baird.

Golden Eye.

594. BUCEPHALA ISLANDICA, Baird.

Barrow's Golden Eye.

595. BUCEPHALA ALBEOLA, Baird.

Butter Ball.

596. HISTRIONICUS TORQUATUS, Bonap.

Harlequin Duck.

597. HARELDA GLACIALIS, Leach.

South Southerly.

598. POLYSTICTA STELLERI, Eyton.

Steller's Duck.

599. LAMPRONETTA FISCHERI, Brandt.

Spectacled Eider.

600. CAMPTOLAEMUS LABRADORIUS, Gray.

Labrador Duck.

601. MELANETTA VELVETINA, Baird.

Velvet Duck.

602. PELIONETTA PERSPICILLATA, Kaup

Surf Duck.

603. PELIONETTA TROWBRIDGII, Baird.

Long-billed Scoter.

604. OIDEMIA AMERICANA, Swains.

Scoter.

605. OIDEMIA BIMACULATA, Baird.

Huron Scoter.

606. SOMATERIA MOLLISSIMA, Leach.

Eider Duck.

607. SOMATERIA V. NIGRA, Gray.

Pacific Eider.

608. SOMATERIA SPECTABILIS, Leach.

King Eider.

609. ERISMATURA RUBIDA, Bonap.

Ruddy Duck.

610. ERISMATURA DOMINICA, Eyton.

Black Masked Duck.

611. MERGUS AMERICANUS, Cass.

Sheldrake.

612. MERGUS SERRATOR, Linn.

Red-breasted Merganser.

613. LOPHODYTES CUCULLATUS, Reich.

Hooded Merganser.

614. MERGELLUS ALBELLUS, Selby.

Smew.

615. PELECANUS ERYTHRORHYNCHUS, Gm.

American Pelican.

616. PELECANUS FUSCUS, Linn.

Brown Pelican.

617. SULA BASSANA, Briss.

Gannet.

618. SULA FIBER, (L.)

Booby.

619. TACHYPETES AQUILA, Vieillot.

Man-of-war Bird.

620. GRACULUS CARBO, Gray.

Common Cormorant.

621. GRACULUS PERSPICILLATUS, Lawr.

Pallas's Cormorant.

622. GRACULUS CINCINNATUS, Gray.

Tufted Cormorant.

623. GRACULUS DILOPHUS, Gray.

Double-crested Cormorant.

624. GRACULUS FLORIDANUS, Bonap.

Florida Cormorant.

625. GRACULUS MEXICANUS, Bonap.

Mexican Cormorant.

626. GRACULUS PENICILLATUS, Bonap.

Brandt's Cormorant.

627. GRACULUS VIOLACEUS, Gray.

Violet Green Cormorant.

628. PLOTUS ANHINGA, Linn.

Snake Bird; Water Turkey.

629. PHAETON FLAVIROSTRIS, Brandt.

Yellow-billed Tropic Bird.

630. DIOMEDEA EXULANS, Linn.

Wandering Albatross.

631. DIOMEDEA BRACHYURA, Temm.

Short-tailed Albatross.

632. DIOMEDEA CHLORORHYNCHUS, Gmel.

Yellow-nosed Albatross.

633. DIOMEDEA FULIGINOSA, Gmel.

Sooty Albatross.

634. PROCELLARIA GIGANTEA, Gmel.

Gigantic Fulmar.

635. PROCELLARIA GLACIALIS, Linn.

Fulmar Petrel.

636. PROCELLARIA PACIFICA, Aud.

Pacific Fulmar.

637. PROCELLARIA TENUIROSTRIS, Aud.

Slender-billed Fulmar.

638. PROCELLARIA MERIDIONALIS, Lawr.

Tropical Fulmar.

639. DAPTION CAPENSIS, Steph.

Cape Pigeon.

640. THALASSIDROMA FURCATA, Gould.

Fork-tailed Petrel.

641. THALASSIDROMA HORNBYI, Gray.

Hornby's Petrel.

642. THALASSIDROMA LEACHII, Temm.

Leach's Petrel.

643. THALASSIDROMA MELANIA, Bonap.

Black Stormy Petrel.

644. THALASSIDROMA WILSONI, Bonap.

Wilson's Petrel.

645. THALASSIDROMA PELAGICA, Bonap.

Mother Carey's Chicken.

646. FREGETTA LAWRENCII, Bonap.

Black and White Petrel.

647. PUFFINUS MAJOR, Faber.

Greater Shearwater.

648. PUFFINUS FULIGINOSUS, Strick.

Sooty Shearwater.

649. PUFFINUS ANGLORUM, Temm.

Mank's Shearwater.

650. PUFFINUS OBSCURUS, Lath.

Dusky Shearwater.

651. PUFFINUS CINEREUS, Gmel.

Cinereous Petrel.

652. STERCORARIUS CATARRACTES, Temm.

Common Skua.

653. STERCORARIUS POMARINUS, Temm.

Pomarine Skua.

654. STERCORARIUS PARASITICUS, Temm.

Arctic Skua.

655. STERCORARIUS CEPPHUS, Ross.

Buffon's Skua.

656. LARUS GLAUCUS, Brünn.

Burgomaster.

657. LARUS GLAUCESCENS, Licht.

Glaucous-winged Gull.

658. LARUS LEUCOPTERUS, Faber.

White-winged Gull.

659. LARUS CHALCOPTERUS, Lawr.

Gray-winged Gull.

660. LARUS MARINUS, Linn.

Great Black-backed Gull.

661. LARUS ARGENTATUS, Brünn.

Herring Gull.

662. LARUS OCCIDENTALIS, Aud.

Western Gull.

663. LARUS CALIFORNICUS, Lawr.

California Gull.

664. LARUS DELAWARENSIS, Ord.

Ring-billed Gull.

664a. LARUS BRACHYRHYNCHUS, Rich.

Short-billed Gull.

665. LARUS SUCKLEYI, Lawr.

Suckley's Gull.

666. BLASIPUS HEERMANNI, Bonap.

White-headed Gull.

667. CHROICOCEPHALUS ATRICILLA, Linn.

Laughing Gull.

668. CHROICOCEPHALUS FRANKLINII, Bru.

Franklin's Rosy Gull.

669. CHROICOCEPHALUS CUCULLATUS, Br.

Hooded Gull.

670. CHROICOCEPHALUS PHILADELPHIA,

Bonaparte's Gull.

671. CHROICOCEPHALUS MINUTUS, Bruch.

Little Gull.

672. RISSA TRIDACTYLA, Bonap.

Kittiwake Gull.

673. RISSA SEPTENTRIONALIS, Lawr.

North Pacific Kittiwake.

674. RISSA BREVIROSTRIS, Brandt.

Short-billed Kittiwake.

675. RISSA NIVEA, Bruch.

Yellow-billed Gull.

676. PAGOPHILA EBURNEA, Kaup.

Ivory Gull.

677. PAGOPHILA BRACHYTARSI, Hölb.

Short-legged Gull.

678. RHODOSTETHIA ROSEA, Jard.

Wedge-tailed Gull.

679. CREAGRUS FURCATUS, Bonap.

Swallow-tailed Gull.

680. XEMA SABINII, Bonap.

Fork-tailed Gull.

681. STERNA ARANEA, Wils.

Marsh Tern.

682. STERNA CASPIA, Pallas.

Caspian Tern.

683. STERNA REGIA, Gambel.

Royal Tern.

684. STERNA ELEGANS, Gambel.

Elegant Tern.

685. STERNA ACUFLAVIDA, Cabot.

Cabot's Tern.

686. STERNA HAVELLI, Aud.

Havell's Tern.

687. STERNA TRUDEAUII, Aud.

Trudeau's Tern.

688. STERNA FULIGINOSA, Gm.

Sooty Tern.

689. STERNA WILSONI, Bonap.

Wilson's Tern.

690. STERNA MACROURA, Naum.

Arctic Tern.

691. STERNA FORSTERI, Nutt.

Forster's Tern.

692. STERNA PARADISEA, Brünn

Roseate Tern.

693. STERNA PIKEI, Lawr.

Slender-billed Tern.

694. STERNA FRENATA, Gambel.

Least Tern.

695. HYDROCHELIDON PLUMBEA, Wils

Short-tailed Tern.

696. ANOUS STOLIDUS, Leach.

Noddy Tern.

697. RHYNCHOPS NIGRA, Linn.

Black Skimmer.

698. COLYMBUS TORQUATUS, Brünn.

Loon.

699. COLYMBUS ARCTICUS, Linn.

Black-throated Diver.

700. COLYMBUS PACIFICUS, Lawr.

Pacific Diver.

701 COLYMBUS SEPTENTRIONALIS, Linn.

Red-throated Diver.

702. PODICEPS GRISEIGENA, Gray.

Red-necked Grebe.

703. PODICEPS CRISTATUS, Lath.

Crested Grebe.

703a. PODICEPS COOPERI, Lawr.

Cooper's Grebe.

704. PODICEPS OCCIDENTALIS, Lawr.

Western Grebe.

705. PODICEPS CLARKII, Lawr.

Clark's Grebe.

706. PODICEPS CORNUTUS, Latham.

Horned Grebe.

707. PODICEPS CALIFORNICUS, Heermann.

California Grebe.

708. PODICEPS AURITUS, Lath.

Eared Grebe.

708a. PODICEPS DOMINICUS, Lath.

White-winged Grebe.

709. PODILYMBUS PODICEPS, Lawr.

Carolina Grebe.

710. ALCA IMPENNIS, Linn.

Great Auk.

711. ALCA TORDA, Linn.

Razor-billed Auk.

712. MORMON CIRRHATA, Bonap.

Tufted Puffin.

713. MORMON CORNICULATA, Naum.

Horned Puffin.

714. MORMON GLACIALIS, Leach.

Sea Parrot; Puffin.

715. MORMON ARCTICA, Illiger.

Arctic Puffin.

716. SAGMATORRHINA LABRADORIA, Cas.

Labrador Auk.

717. CERORHINA MONOCERATA, Cassin.

Sea Horn-bill.

718. CERORHINA SUCKLEYI, Cassin.

719. PHALERIS CRISTATELLA, Bonap.

Crested Auk.

720. PHALERIS TETRACULA, Stephens.

Dusky Auk.

721. PHALERIS CAMTSCHATICA, Cassin.

Kamtschatkan Auk.

722. PHALERIS MICROCEROS, Brandt.

723. PHALERIS PUSILLA, Cassin.

Least Auk.

724. PTYCHORHAMPHUS ALEUTICUS, Brt.

Cassin's Guillemot.

725. OMBRIA PSITTACULA, Eschsch.

Parrot Auk.

726. URIA GRYLLE, Latham.

Black Guillemot.

727. URIA COLUMBA, Cassin.

Western Guillemot.

728. URIA CARBO, Brandt.

Crow Guillemot.

729. URIA LOMVIA, Brünnich.

Foolish Guillemot.

730. URIA RINGVIA, Brünnich.

Murre.

731. URIA ARRA, (Pallas.)

Thick-billed Guillemot.

732. BRACHYRHAMPHUS MARMORATUS,

Marbled Guillemot.

733. BRACHYRHAMPHUS WRANGELII, Br.

Wrangel's Guillemot.

734. BRACHYRHAMPHUS BRACHYPTERUS

Short-winged Guillemot.

735. BRACHYRHAMPHUS KITTLITZII, Br

Kittlitz's Guillemot.

736. BRACHYRHAMPHUS ANTIQUUS, Br.

Ancient Auk.

737. BRACHYRHAMPHUS TEMMINCKII, Br.

Temminck's Guillemot.

738. MERGULUS ALLE, Vieillot.

Sea Dove.

ALPHABETICAL INDEX OF GENERA OF BIRDS.

(THE NUMBERS ARE THOSE OF THE FIRST SPECIES MENTIONED IN THE CATALOGUE.)

CATALOGUE

OF

NORTH AMERICAN REPTILES

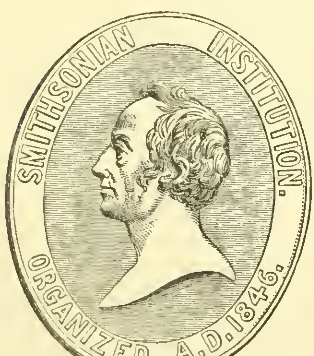
IN THE MUSEUM OF THE

SMITHSONIAN INSTITUTION.

PART I.—SERPENTS.

BY

S. F. BAIRD AND C. GIRARD.



WASHINGTON:
SMITHSONIAN INSTITUTION.
JANUARY, 1853.

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CONTENTS.

PREFACE.

In the present catalogue it is proposed to present a systematic account of the collection of North American Serpents in the museum of the Smithsonian Institution. In the Appendix will be found such species not in possession of the Institution, as could be borrowed for description, as well as notes on more or less authentic species of which no specimens could be found.

A complete synonomy of all the species has not been attempted, as tending to swell the bulk of a catalogue too much. All those, however, necessary to a proper understanding of the history or character of the species, have been introduced, and all the synonyms quoted have been actually verified by original reference.

Owing to the want of osteological preparations, it has been a difficult task to arrange the genera in a natural succession. In many cases forms are now combined which will hereafter necessarily be widely separated. The almost entire deficiency of modern general works upon the *Colubridæ*, has also been a serious obstacle to any correct idea of a natural system. The forthcoming work of M. M. Duméril will undoubtedly clear up much of the obscurity which now exists. But when systematic writers all carefully avoid the subject of the Ophidians, each waiting for the others to make the first step, the attempt to combine genera by well marked, though perhaps artificial points of relation, will it is hoped be looked upon with indulgence, even after more comprehensive and extended investigations shall render it necessary to break up the combinations here adopted.

The collections upon which the original descriptions of the present catalogue have been based are as follows:—

Spencer F. Baird. Species from Massachusetts, New York, Ohio, and Pennsylvania.

Charles Girard. Maine, Massachusetts, and South Carolina.

Rev. Charles Fox. Species from Eastern Michigan.

Dr. P. R. Hoy. Species from Eastern Wisconsin.

Prof. L. Agassiz. Lake Superior, Lake Huron, and Florida.

Dr. J. P. Kirtland. Northern Ohio.

G. W. Fahnestock. Western Pennsylvania.

Miss Valeria Blaney. Eastern Shore of Maryland.

Dr. C. B. R. Kennerly. Northern Virginia.

John H. Clark. Maryland, Texas, New Mexico, and Sonora.

John Varden. District of Columbia and Louisiana.

Dr. J. B. Barratt. Western South Carolina.

Miss Charlotte Paine and Mrs. M. E. Daniel. Western S. Carolina.

Dr. S. B. Barker. Charleston, S. C.

Prof. F. S. Holmes and Dr. W. J. Burnett. South Carolina.

R. R. Cuyler and Dr. W. L. Jones. Georgia.

D. C. Lloyd. Eastern Mississippi.

Dr. B. F. Shumard and Col. B. L. C. Wailes. Mississippi.

James Fairie. Mexico and Western Louisiana.

Capts. R. B. Marcy and G. B. McClellan, U. S. A. Red River, Ark.

Ferdinand Lindheimer. Central Texas.

Col. J. D. Graham, U. S. A. The specimens collected while on the U. S. and Mex. Boundary Survey, by Mr. J. H. Clark, viz., in Texas, New Mexico, and Sonora.

Maj. W. H. Emory. Specimens collected on the U. S. and Mexican Boundary Survey, by Arthur Schott, at Eagle Pass, Tex., and by J. H. Clark, in Texas and New Mexico.

Gen. S. Churchill, U. S. A. Valley of the Rio Grande.

Dr. L. Edwards, U. S. A. Northern Mexico.

Dr. Wm. Gambel. New Mexico and California.

Dr. John L. Le Conte. Littoral California.

Dr. C. C. Boyle and J. S. Bowman. Central California.

Dr. A. J. Skilton. Species collected in California by Henry Moores, Esq.

U. S. Exploring Expedition. Littoral California and Oregon.

Academy of Natural Sciences of Philad. Various unique specimens described by Dr. Holbrook.

Boston Society of Natural History. California.

SPENCER F. BAIRD,
Assist. Sec. S. I. in charge of Museum.

Smithsonian Institution,
January 5, 1853.

INTRODUCTION.

EXPLANATION OF TERMS USED.

THE *vertical* plate is the central one in the middle of the head above, having on each side of it the *superciliaries*, which form the upper part of the orbit. The two plates behind the vertical are the *occipitals;* the pair in front of it, the *postfrontals.* The *prefrontals* or *anterior frontals* are situated in front of the postfrontals; and anterior to these and terminating the snout is the *rostral.* The plates immediately in front of the eye are the *anteorbitals;* those behind it are the *postorbitals.* In advance of the anteorbital is the *loral,* between which and the rostral are the two *nasals,* with the nostril between them. The *upper* and *lower labials* margin the upper and lower jaws. The *temporal* shields are situated between the upper labials and the occipitals. The *inframaxillary* or *mental* scutellæ or shields are just within the lower labials.

The arrangement on the top of the head of one rostral, two pairs of frontals, one vertical with one superciliary on each side, and one pair of occipitals we have considered as typical or normal, from which but few of the genera described vary. Sometimes one plate occupies the place of the two prefrontals, and in some genera a second median plate is seen between the rostral, frontals, and vertical. On the side of the head we have sometimes but one nasal, and sometimes either the loral or the anteorbitals may be wanting. Where the latter condition exists, it is sometimes difficult at first to determine which plate has disappeared. A clue is to be found in the shape of the remaining plate; if this be longitudinal, it is probably the loral; if vertical, or divided into two or more, one above the other, it is to be considered as anteorbital. The loral belongs to the postfrontals, and the anteorbital to the vertical, the posterior edges in the former and

the anterior in the latter generally ranging. Thus, when the vertical plate is very short, the anteorbital is also short or wanting entirely, and the same relation holds good between the loral and postfrontals.

The specimen whose measurements are first given, unless stated to the contrary, has served as the type of the description, and the first mentioned species is to be considered as the type of the genus.

Of the five numbers given at the end of the descriptions, the first indicates the number of the abdominal scutellæ from chin to anus. The second is that of the pairs of subcaudal scutellæ; the third, the dorsal rows or the number of rows of scales around the body (excluding the abdominal series). The fourth number shows the entire length of the animal, and the fifth the length of the tail, in English inches.

In referring to the dorsal rows, the exterior one, or that next the scutellæ, is considered to be the first, unless the contrary is stated.

When there are two numbers separated by the symbol at the beginning of the measurements, the first indicates the number of entire abdominal scutellæ, the latter of those that are bifid or divided. The subcaudal scutellæ are to be considered as divided or in pairs, unless mentioned to the contrary.

In enumerating the number of labial plates, those on one side of the jaws only are to be understood, and the terminal and median one on the symphysis of the upper and lower maxillaries is never included. On the upper jaw that plate is at the end of the snout, and is the rostral.

The descriptions are all based on specimens preserved in alcohol, unless otherwise stated.

Synopsis of Families and Genera, and list of Species of North American Serpents.

Family I.—**Crotalidae.** Erectible poison fangs, in front. Few teeth in upper jaw. A deep pit between the eye and nostril.

Family II.—**Colubridae.** Both jaws fully provided with teeth. No anal appendages.

A. *Loral and anteorbital both present.*

B. *Either loral or anteorbital absent.*

Family III.—**Boidae.** Both jaws with teeth. Rudiments of hinder limbs or spur-like anal appendages.

Family IV.—**Typhlopidae.** Teeth only in one jaw, either the upper or lower. Upper jaw strongly projecting. Scales on the belly instead of scutellæ, disposed in several series like those on the upper surface.

Family I.—CROTALIDÆ.

			Page
Tail with a rattle. Top of head covered	with small scale-like plates	**Crotalus**	1
	with large plates arranged as in *Coluber*	**Crotalophorus**	11
Tail without a rattle. Loral plate	present	**Agkistrodon**	17
	absent	**Toxicophis**	19

Family II.—COLUBRIDÆ.

A. *Loral and anteorbital both present.*

Dorsal Scales					Genus	Page
smooth.	A permanently erect poison fang on each side				Elaps	21
carinated. Plates on vertex	typical. Postorbitals	three. Postabdominal scutella	entire		Eutainia	24
			divided		Nerodia	38
		two. Loral	excluded from orbit		Regina	45
			entering in orbit		Ninia	49
	not typical. Labials	excluded from the orbit			Heterodon	51
		entering into the orbit			Pituophis	64
	typical. Median dorsal rows only carinated				Scotophis	73
smooth, except *Leptophis*. Postabd. scut.	entire. Dorsal scales	not imbricated. Superciliaries narrow			Ophibolus	82
		imbricated. Superciliaries broad			Georgia	92
	divided. Vertical plate	long, narrow. Rostral	normal.	Postorbitals on the 4th labial	Bascanion	93
				" on the 5th labial	Masticophis	98
			with lateral edges above the level of nasals		Salvadora	104
		short, broad. Snout obtuse.	One nasal. Scales	carinated	Leptophis	106
				smooth. Postorbitals two	Chlorosoma	108
				smooth. Postorbitals one	Contia	110
			Two nasals. Anteorbitals	two	Diadophis	112
				one. Postorbitals two	Lodia	116
				one. Postorbitals three	Sonora	117
		broad. Snout pointed. Subcaudal scutellæ	divided		Rhinostoma	118
			entire		Rhinocheilus	120

Family II.—COLUBRIDÆ, *continued.*

B. *Loral or anteorbitals absent.*

					Page
Anteorbitals absent. Prefrontals	one. Scales	carinated		Haldea	122
		smooth		Farancia	123
	two. Scales smooth. Post-orbitals	two.	One nasal	Abastor	125
			Two nasals	Virginia	127
		one.		Celuta	129
Loral absent. Scales	smooth	Postabdom. sc. divided		Tantilla	131
		" " entire		Osceola	133
	carinated			Storeria	135

Family III.—BOIDÆ.

				Page
Anteorbitals & superciliaries	one.	Loral one	Wenona	139
	three.	Lorals two	Charina	154

Family IV.—TYPHLOPIDÆ.

			Page
Cephalic plates consisting of	Frontonasals, nasals, oculars, parietals, and postparietals	Rena	142
	Prefrontals, frontal proper, fronto-nasals, nasals, oculars, pre- and supra-oculars, and parietals	Ophthalmidion	155

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			short, broad. Snout obtuse.	One nasal. Scales	carinated		Leptophis	106
					smooth. Postorbitals	two	Chlorosoma	108
						one	Contia	110
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Systematic Index of well-ascertained Species of North American Serpents.

(The new species are indicated by an asterisk).

CROTALUS, Linn.

CROTALOPHORUS, Gray.

AGKISTRODON, Beauv.

TOXICOPHIS, Troost.

ELAPS, Fitz.

EUTAINIA, B. & G.

DIADOPHIS, B. & G.

LODIA, B. & G.

SONORA, B. & G.

RHINOSTOMA, Fitz.

RHINOCHEILUS, B. & G.

HALDEA, B. & G.

FARANCIA, Gray.

ABASTOR, Gray.

VIRGINIA, B. & G.

CELUTA, B. & G.

TANTILLA, B. & G.

OSCEOLA, B. & G.

STORERIA, B. & G.

WENONA, B. & G.

RENA, B. & G.

SUMMARY.

Genera.	Old	13	
	New	22	
	Total		35
Species.	Old	65	
	New	54	
	Total		119

SPECIES NOT SEEN.

SERPENTS.

Genus **CROTALUS**,* Linn.

Gen. Char. Upper surface of head covered with small plates, scale-like, with a few larger ones in front. The tail is terminated by a well-developed rattle. A deep pit between the eyes and the nostrils. Subcaudal scutellæ entire. Temporal and labial shields small and convex.

1. Crotalus durissus, Linn.—Head angular. Scales between the superciliaries small, numerous, uniform. Plates above snout, 2 anterior frontal, and 5 postfrontal. Suborbital chain continuous, of large scales. Two rows between this and labials. Labials 12–14 above, 5th largest; 13–15 below. Scales on the back 23–25, all carinated; carination on outer row obsolete. Tail black. Above sulphur-brown, with two rows of confluent brown lozenges. Light line from superciliary to angle of the mouth. Behind this a dark patch.

Syn. *Crotalus durissus*, Linn. Syst. Nat. I. 1766, 372.—Gm. *Linn.* Syst. Nat. ed. xiii. I., III. 1788, 1081.—Holbr. N. Amer. Herp. III. 1842, 9. Pl. i. —Dekay, New Y. Fauna. Pt. III. 1842, 55. Pl. ix., fig. 19.—Storer, Rep. Rept. of Mass. 1839, 233.

Vipera caudisona americana, Catesb. Nat. Hist. Carol. II. 1743, 41. Pl. lxi.

Banded Rattlesnake.

Head above covered with small subtuberculous scales. Superciliaries large. Anterior frontals large, triangular, emarginated behind to receive a series of three small plates. A single subhexagonal plate between the superciliary and anterior frontal. The exterior plate of the posterior frontal row is much the largest, and is in contact with

* The names and characteristics of the higher divisions will be given in the synopsis of species.

The figures at the end of the descriptions refer, the 1st to the number of abdominal scutellæ; 2d, to the subcaudal scutellæ; 3d, to the dorsal rows; 4th, to the total length; and 5th, to the length of the tail.

the superciliaries. A series of three or four larger flat scales extends from the posterior extremity of the superciliary. Scales on the cheeks very large, truncate. Anterior orbitals double; the upper one rectangular, elongated longitudinally; separated from the nasal by two small plates.

General color above, that of roll sulphur; beneath, whitish yellow. Along the back is a double series of subrhomboidal blotches, looking as if they had been in contact, and then the line of junction partially effaced for the three or four central rows. The impression conveyed of the color of these blotches is that of coarse mottlings of soot or gunpowder grains, more crowded exteriorly. There are twenty-one of these blotches from the head to the anus, the tail being entirely black. The rhomboids are enclosed within about twelve dorsal series of scales. Directly opposite to these spots on each side is a series of subtriangular blotches similarly constituted as to colour, and extending from the abdomen to about the fifth lateral row, and some six or seven scales long. Anteriorly these are distinct from the dorsal series, but posteriorly they are confluent with them, forming a series of zigzag blotches across the body. The scutellæ below show more or less of the grain-like mottlings. Posteriorly the yellow of the body is suffused with darker.

There are no markings of lines distinctly visible on the sides of the head. In the centre of the spaces between the dorsal and lateral series of blotches are indications of small obsolete spots; and in some cases the yellow scales external to the blotches are of lighter colour than the rest.

Huntingdon Co., Pa. 166. 25. 23. 42. 5. D. C. Lloyd.

Another specimen has the ground-color darker, more brownish yellow. The markings, however, are on the same pattern, except that the line of junction of the blotches is not so much effaced, and the colors more decided. Lateral row of scales smooth, not cariated Plates of head similar. Fifteen labial plates, fourth upper one the largest. The blotches are nearly uniform umber-brown, margined with darker; the scales external to which are lighter than the ground-color.

Lycoming Co., Pa. 165. 25. 23. 25. 3½. S. F. Baird.

A female from Huntingdon Co., Pa., has the general pattern of the one last mentioned, but a dark brown tint pervades the whole

body, and obscures the pattern of coloration. External row of scales smooth. The inferior orbital chain is composed of scales nearly as large as the two next rows.

Huntingdon Co., Pa. ♀ 168. 18. 23. 35. 3½. S. F. Baird.

In a specimen from Prairie Mer Rouge, La., the general system of coloration is similar; it differs principally in having a reddish brown strip or tint down the back, for a width of some three scales, extending from head to tail. First row of lateral scales smooth. Plates of head as described, except that there are but two plates embraced between the two postfrontals. The upper jaw pale cream colour, the line of demarcation starting from the anterior canthus, and passing backward to the angle of the mouth, along the edge of the labials, or rather a narrow cream-colored line beginning on the upper labials, at the angle of the mouth, and widening on the fifth plate, encloses the whole anterior portion of the face below the nostrils. The white patch closely mottled with black beneath the eye. A brown patch across and beneath the angle of the mouth, interrupted by the white just mentioned.

Prairie Mer Rouge, La. 165. 27. 25. — — Jas. Fairie.
Mississippi. Col. Wailes.

2. Crotalus adamanteus, Beauv.—Head triangular. Two anterior frontals, connected with superciliaries on each side by two large plates: inside of these a second row; included space filled by small scales. Scales margining superciliaries small; scattered larger ones toward the centre of the intermediate space. Three rows of scales between the suborbitals and labials. Suborbitals extending to the middle of the orbit. Labials 15 or 16 above; 1st, 5th, and 7th largest and vertical;—below, 18; 1st, 4th, and 5th largest. Dorsal rows 27; outer rows obsoletely carinated. Three or four dark rings on tail. Three series of well-defined perfect rhombs, one dorsal, two lateral, separated by narrow lines. Light stripe from superciliary to the angle of the mouth. A second in front of the eye.

Syn. *Crotalus adamanteus*, Beauv. Trans. Amer. Philos. Soc. IV, 1824, 368.—Holbr. N. Amer. Herp. III, 1842, 17. Pl. ii.

C. horridus, Harl. Journ. Acad. Nat. Sc. Philad. V, ii, 1827, 370.

Diamond Rattlesnake.

Scales on the cheek smooth. Three rather large plates on the edge of the upper part of the head, between the superciliaries and rostral, inside of which is a second row of three, also larger than the rest.

The two lower rows of lateral scales smooth. Third and fourth very faintly carinated. Scales on the back and sides not conspicuously different in size except the lower 2 or 3 rows. Posteriorly, near the tail, all the scales are carinated except the lowest.

General color, yellowish gray, with rhomboidal black blotches, lighter in the centre, and with all the angles perfect. Or rather there is a series of dull yellowish lines crossing obliquely from one side of the abdomen to the other over the back, following the oblique series of scales, and occupying generally the posterior half of each scale, the basal portion being black. These lines, of which there are about 36 crossing from each side, from head to tail, (9 on tail,) decussate first on the 5th or 6th lateral row, and then on the back, where they are more or less confluent three or four rows. The rhomboids thus enclosed and crossing the back are generally black for 1½ or 2 scales within the yellowish lines, and the most central portion is dark yellowish brown, mottled with darker. The intervals on the sides between the lines are mostly dark yellowish brown, minutely mottled with dark brown. These intervals constitute a lateral series of transverse rhomboids, sometimes with the lower angle truncated. Opposite to the dorsal rhomboids is a series of small triangles in the angles of the first decussation. The distance between two parallel transverse stripes generally consists of five rows of scales, occasionally of six.

On the sides and posteriorly these markings are more or less indistinct, though generally recognisable. The tail usually exhibits a good deal of black. The under parts are dull yellowish white, or greenish white, clouded toward the sides with brown. No regular spots visible. The black on the tail does not constitute complete rings, but is interrupted in the middle of the lower surface, and in fact the black patches alternate with each other, and are not opposite.

The top of the head is light brown, with occasional black scales. A dull yellowish streak starts at the posterior edge of the superciliary plate, and passing obliquely backward, through two rows of scales, extends to the angle of the mouth. A second band starts on the plate in advance of the superciliary, and crossing the anterior orbitals, expands till it involves the 7th, 8th, and 9th upper labials. Interval between the first two stripes dark brown. There are also indications of a second vertical light bar in front of the nostril, and two below the pit. Rostral dark yellowish, lighter in the margin.

Charleston, S. C. 169. 32. 27. 48. 5¼. Dr. Barker.

3. Crotalus atrox, B. & G.—Head subtriangular. Plates on head; 2 anterior frontals in contact, between these and superciliaries, on side of the crown, 2 imbricated plates. Space enclosed occupied by smaller scales. Superciliaries bordered by a row of larger scales; the anterior much largest. Three rows of scales between labials and suborbitals. Labials 16 above; 1st, 5th, and 7th largest;—15 below, 1st and 3d largest. Dorsal rows 25–27: 2 exterior rows smooth. On the tail 3–6 half rings. Color yellowish brown, with a continuous succession of dorsal lozenges, sometimes truncate before and behind; intervals all narrow. A single transverse light line on superciliary. Stripe from superciliary directly to the angle of the mouth.

General style of coloration somewhat as in *C. adamanteus*. Ground-color above dull yellowish brown, with a series of subhexagonal patches from the head nearly to the tail, in an uninterrupted series, separated throughout by narrow lines. We may refer the markings to the intersection of two series of light yellowish lines, about 40 in number, crossing obliquely from each side across to the other, along the anterior half of as many oblique series of scales. The lateral decussation is along the sixth row of dorsal scales; on the back, where they cross, the lines are confluent for a breadth of five or six scales, making a series of transverse lines across the back, truncating the obtuse angles of the rhomboids, which would otherwise be produced. Sometimes the acute lateral angle of the rhomboids are also truncated. Laterally, the yellowish lines are more or less obsolete, leaving a more or less distinct chain pattern. The rhomboids or subrhomboids enclosed have a narrow margin of dark brown, lighter toward the centre. In all cases the interval between the successive rhomboids is but one or two half scales in width. The lateral rhomboids and triangles referred to in *C. adamanteus* are indicated by two alternating series of dark brown blotches, the first along the 3d and 4th lateral row, opposite the apices of the rhomboids; the second along the 6th and 7th, and alternating with the same; the spots occupy one scale, or part of four contiguous ones. Space between these rhomboids and the yellowish lines, dull yellowish brown. Beneath nearly uniform yellowish, slightly clouded on the sides of the scales. On the tail the blotches are confluent into 3 or 6 dark brown half rings, interrupted on the under surface. General distribution of lines on the head much as in *C. adamanteus;* a narrow light line from the posterior end of the superciliary backward, directly to the

angle of the mouth; a second from the anterior extremity, nearly parallel with the first, the two enclosing an indistinct patch, and separated on the labials by 4½ scales. There is also a single narrow light line across the superciliary perpendicular to its length, obsolete in old specimens.

It may readily be distinguished from *C. adamanteus* by its light color and the truncations of the rhomboids, as well as the general obsoleteness of the lateral markings. The rhomboids are longer in proportion and more rounded. The two lateral rows of scales are smooth, the next two more strongly carinated than in *C. adamanteus*. The 5th upper labial is largest, and transverse; the rest nearly uniform. The stripes on the side of the head are less distinct.

From *C. confluentus*, it may be distinguished by the greater comparative size of the interval between the dorsal blotches, especially posteriorly. In *C. confluentus*, there are two light lines across the superciliary plate, dividing it into three sections, the central rather narrower. Here, too, the posterior facial stripe, instead of passing to the angle of the mouth, goes back of it on the 2d row above the labials, in *C. atrox*, passing directly to the angle of the mouth. Other important distinctions are seen in the narrower scales of *C. confluentus*, &c.

From *C. lucifer*, the more narrow head, fewer and larger intersuperciliary scales, lighter color, arrangement of color along the head, will at once distinguish it.

Indianola.	187. 23. 25.	33. 3⅛.	Col. J. D. Graham.
"	183. 27. 27.	39½. 4⅞.	"
"	177. 28. 25.	36. 4⅝.	"
"	187. 23. 25.	15¾. 1½.	"
San Pedro, Texas.	177. 28. 25.	36. 4⅝.	"

4. Crotalus lucifer, B. & G. Muzzle broad. Scales between the superciliaries numerous, small, and uniform. Plates on top of head, 4 prefrontal, 4 postfrontal, or else irregular. Three rows scales between the suborbitals and labials. Labials 16 above; 1st and 5th largest;—15 below. Dorsal rows 25, exterior smooth, 2d and 3d with obsolete carination. Tail, and posterior portion of body with 16 or 17 half rings. A succession of brown dorsal hexagons or octagons, separated throughout by a narrow lighter line. Light stripe from superciliary crosses the angle of the mouth on the 3d and 4th row above labial.

SYN. *Crotalus lucifer*, B. & G. Proc. Acad. Nat. Sc. Phila. VI., 1852, 177

Head very broad anteriorly, outline little tapering. Head above covered with many small tuberculiform scales, showing a substelliform radiation. Interval between superciliary plates filled with small scales, nearly uniform in size; row bordering the superciliaries very small. Scales in front of the superciliaries variable: in one specimen there are two rows of four each, of considerable size; in another they are larger than the rest, but irregular. Scales on the cheeks large, flat, smooth.

Ground-color, light brown above. Along the back a series of subhexagonal or octagonal blotches, formed by a skeleton of dull yellowish, constituting a dorsal chain. The space thus enclosed of the ground-color is margined faintly with dark brown: the width of the interval between the successive blotches is from one-half to one and a half scales. These spots are frequently confluent, two and three running together. Where most distinct the spots are four scales long and eleven wide. On each side of this dorsal series is a second, separated by a single row of scales, the blotches extending from the abdominal scutellæ to the 5th or 6th row. These are smaller than the dorsal, and subcircular. Opposite the transverse light bands, and in the open space between four contiguous blotches on the sides, smaller blotches are indistinctly visible. Posteriorly, the spots on the back and sides are confluent and darker; in one specimen forming 17 half rings, encircling the back, leaving about 24 dorsal blotches. Abdomen greenish yellow, more or less clouded with brown at the bases of the scales. Head dark brown; a light line from posterior portion of the superciliaries along the 4th row of supralabial scales back to the angle of the jaws, on the occiput, where it expands into the color of the under part. Upper labials of the same light color behind, rapidly widening anteriorly so as to include whole front and side of the face, leaving only the top of the head dark. The space about the facial pit darker.

The theory of coloration is that of decussating lines, which, when they intersect, unite so as to have the angles of intersection truncated.

The species has a general resemblance to *C. atrox* in the arrangement of the blotches, but is darker, and has about 17 dark half rings posteriorly instead of 4 or 5. In *C. atrox* the head is narrower and more triangular, the space between the superciliaries narrow, and occupied by angulated larger scales instead of small tuberculous ones. In *C. atrox*, the row bordering the superciliaries is much larger than the rest, and the scales on the top of the head generally more angu-

lated. In *C. lucifer*, the line on the side of the head, instead of going directly from the posterior end of the superciliary to the commissures, passes back nearly parallel to the mouth, crossing along the 4th row of scales above the labial. The second line in front of the eye is much wider below in *C. lucifer*, and the face generally shows more of white, while the dark portions are much darker.

A specimen collected in California by Dr. Leconte resembles this, but owing to the imperfect state of preservation, little definite can be ascertained. The dorsal figures are, however, more in lozenges than in hexagons. Color dark. Size, very large.

Oregon. 168. 25. 25. 27¾. 3¾. (in dep.) Expl. Exped.

5. Crotalus confluentus, Say. Head subtriangular. Plates on top of head squamiform, irregular, angulated, and imbricated; scales between superciliaries small, numerous, uniform. Four rows of scales between the suborbital series (which only extends to the centre of the orbit) and the labials. Labials 15 or 18, nearly uniform. Dorsal series 27–29. Dorsal blotches quadrate, concave before and behind; intervals greater behind. Spots transversely quadrate posteriorly, ultimately becoming 10 or 12 half rings. Two transverse lines on superciliaries, enclosing about one-third. Stripe from superciliary to angle of jaws, crosses angle of the mouth on the second row above labial. Rostral margined with lighter.

Syn. *Crotalus confluentus*, Say, in *Long's* Exped. Rocky Mts. II, 1823, 48.
C. Lecontei, Hallow. Proc. Acad. Nat. Sc. Philad. VI, 1851, 180.

This species bears a considerable resemblance to *C. atrox*, but the body is more slender and compact. Scales on the top of the head anterior to the superciliaries nearly uniform in size. Line of scales across from one nostril to the other consists of six, not four as in *C. atrox*. Superciliaries more prominent. Labial series much smaller. Upper anterior orbitals much smaller, as also is the anterior nasal. Scales on the top of the head less carinated. Scales between superciliaries smaller and more numerous, five or six in number instead of four. Two lateral rows of scales smooth, first, second, and third gradually increasing in size. Scales more linear than in *C. atrox*.

General color yellowish brown with a series of subquadrate dark blotches, with the corners rounded and the anterior and posterior sides frequently concave, the exterior convex. These blotches are ten or eleven scales wide and four or five long, lighter in the centre, and margined for one-third of a scale with light yellowish. The intervals along the back light brown, darker than the margins of the

blotches. Anteriorly the interval between the dark spots is but a single scale; posteriorly it is more, becoming sometimes two scales, where also the spots are more rhomboidal or lozenge-shaped; nearer the tail, however, they become transversely quadrate. The fundamental theory of coloration might be likened to that of *Crotalus adamanteus*, viz. of forty or fifty light lines decussating each other from opposite sides; but the angles of decussation, instead of being acute, are obtuse, and truncated or rounded off throughout. Along the third, fourth, and fifth lateral rows of scales is a series of indistinct brown blotches covering a space of about four scales and falling opposite to the dorsal blotches: between these blotches, and opposite to the intervals of the dorsal blotches, are others less distinct. Along the fifth, sixth, seventh, and eighth rows is a second series of obsolete blotches, each covering a space of about four scales, and just opposite the intervals between the dorsal spots. The dorsal and lower series are separated by an interval of three scales, this interval light brown. Beneath, the color is dull yellowish, and ten or twelve darker half rings are visible on the tail.

In point of coloration the principal features, as compared with *C. atrox*, lie in the dorsal blotches, being disposed in subquadrate spots instead of subrhomboids; the intervals thus forming bands across the back perpendicular to the longitudinal axis. This tendency to assume the subquadrangular pattern has broken up the chain-work into isolated portions, as in *Coluber eximius* or *Crotalophorus tergeminus*. The intervals of the dorsal blotches are wide and darker in the middle, while in *C. atrox* they are narrow, not linear, and unicolor. The sides of the head present the usual light stripe from the posterior extremity of the superciliary; it passes, however, to the angle of the jaw on the neck, along the second row of scales above the labials. A second stripe passes in front of the eye to the labials, widening there. A small light vertical bar is seen below the pit, and another on the outer edge of the rostral. On the superciliaries are seen two light transverse lines enclosing a space nearly one-third of the whole surface. In *C. atrox* there is a single median line. Sometimes, as in *C. atrox*, the single blotches on the nape are replaced by two elongated ones parallel to each other.

Red River.	180. 27. 29.	34. 4.	Capt. Marcy.
San Pedro, Texas.	181. 28. 27.	— –	Col. J. D. Graham.
Bet. San Antonio and El Paso.	188. 23. 27.	27. 3.	" "

6. Crotalus molossus, B. & G. Muzzle broad; rostral small. Scales between superciliaries small, uniform, except the two anterior. Two frontal plates, four postfrontal. Two inter superciliary, all in contact. Five rows scales between the labials and suborbital row. Middle row, not extending beyond the middle of the orbit. Labials 18 above, fifth and sixth largest; 17 below. Dorsal rows of scales 29. Two external rows small. Tail uniform black. Color roll sulphur, a series of chestnut-brown transverse lozenges, with exterior corners produced to the abdomen. Centres of lozenges with one or two spots. Each scale but one color. A brown patch below and behind the eye.

One of the most strongly marked of all the species. Head very broad in front; outline nearly rectangular. Rostral small. Two anterior frontals; behind these four plates, the exterior resting on the superciliary; behind these two other plates, between and in contact with the superciliaries. Anterior nasal subtriangular. Top of head with numerous smooth subtuberculous scales. Suborbitals large, extending to the anterior canthus. General aspect smoother than in Crotali generally, scales rounded at the posterior apex, carinated but slightly.

General color above that of roll sulphur, beneath pale yellowish, posteriorly very faintly clouded with brownish. Tail black. Anteriorly the scutellæ are entirely immaculate. Along the back is a series of transverse reddish or chestnut-brown lozenges embraced in a width of 12 or 14 scales and 4 or 5 scales long, and with the exterior angles produced to the abdomen. These lozenges are frames with the outline generally one scale in width and with the centres of the ground-color; sometimes divided by a median line of brown, so as to show two yellowish spots inside of the lozenges. The scales exterior to the lozenges are rather lighter. Sometimes the brown rings and the lozenges widen at the abdomen and indicate lateral spots of four scales; at others, and especially anteriorly, the rings are obsolete, and the brown is in a dorsal series. In fact, for the anterior fourth of the body we have a dorsal patch of brown, showing alternately at successive intervals one large yellowish spot and then a pair of smaller ones, owing to the confluence of the successive lozenges. The superciliaries and scales anterior to them, as well as a broad patch below and behind the eye, light greenish brown. Tail uniform dark brown above, paler beneath. Only one button with two necks, no rattle.

A remarkable character of this species is that each individual

scale is of the same uniform tint to its base, and not showing two colours as in other species.

Fort Webster, St. Rita del Cobre, N. Mex.	187. 25. 29.	33⅛. 3.	Col. J. D. Graham.

Genus **CROTALOPHORUS**, Gray.

Gen. Char. Upper surface of the head covered with nine large plates, as seen in *Coluber* and allied genera. The tail terminates in a rattle, generally smaller than in *Crotalus*. A deep pit between the eye and nostril, as in *Crotalus*. Subcaudal scutellæ entire, except a few at the end of the tail, which are bifid.

Syn. *Crotalophorus*, Gray, Ann. Philos. 1825, 205.

1. Crotalophorus miliarius, Holbr.—Twenty-two or twenty-three dorsal rows of scales, all of which are carinated, the lateral and first row but slightly; a vertebral brownish red line; seven series of blotches, one dorsal and three lateral, on each side, the uppermost of which is obsolete and the lowest subject to irregularities. Vertical plate subcordiform, occipital oblong and elongated. A narrow white line commences at the lowest point of the orbit and passes obliquely backward to the angle of the mouth.

Syn. *Crotalus miliarius*, Linn. Syst. Nat. I, 372.—Gm. *L.* Syst. Nat. ed. XIII, I, iii, 1788. 1080.—Merr. Vers. Syst. Amph. 1820, 156.—Harl. Jour. Acad. Nat. Sc. Phila. V, ii, 1827, 370. Holbr. N. Amer. Herp. II, 1838, 73 Pl. xv.

Caudisona miliarius, Wagl. Syst. Amph. 1830, 176.

Crotalophorus miliarius, Holbr. N. Amer. Herp. 2d. ed. III, 1842, 25. Pl. iv.

Vipera Caudisona americana minor. Catesb. Nat. Hist. Carol. II, 1743, 42. Pl. xiii.

Ground Rattlesnake.

Ground-color dark greyish ash, minutely mottled. A series of thirty-eight to forty-five subcircular dorsal blotches extending from head to tail, dark brown, each with a narrow distinct yellowish border. Interval rather narrower than the spots themselves. A broad band of purplish red passes from head to tail, through the blotches. On each side may be distinguished three series of blotches, the first on the first and second lateral rows of scales and partly on the abdominal scutellæ. The second alternating with this on the second, third, fourth, and fifth rows of scales, and opposite the dorsal

series. The third alternating with the second and the dorsal series, on the fifth, sixth, seventh, and eighth rows of scales. The latter series is dusky and obsolete; the others are uniform and distinctly black.

The shape of the blotches is subjected to some variation according to individuals. Generally subcircular or slightly oblong, they become sometimes a transversely elongated quadrangle, three times as long as wide. Their shape varies according to the region of the body on which they are found. On the anterior third they are subquadrangular, anteriorly and posteriorly emarginated; on the middle region they elongate, and toward the posterior third become nearly circular. Backward of the anus the five or six blotches of that region extend on the sides, without, however, meeting on the lower surface. The blotches of the first lateral row are subquadrangular and a little smaller than those of the second and third rows; the blotches of the second row being transversely oblong and largest on the middle region of the body. Side of the head purplish brown. A narrow distinct white line from the lowest part of the orbit passing obliquely backward to the angle of the mouth. Above and continuous with that white line a deep chestnut-brown vitta is observed, of the same length but broader and lined above with a narrow dull yellowish margin. Two undulated dark-brown vittæ extend from the vertex to the first dorsal blotch and confluent with it. A double crescentic blotch is observed on the frontal scutellæ leaving a transversal fulvous band across the head between the orbits. The color underneath is reddish yellow, marmorated with brownish black blotches and minute dots.

The scales are elongated, carinated, and acute posteriorly. Those of the lateral row are slightly carinated also, but narrower than in *C. consors*, and more acute posteriorly.

Liberty Co., Georgia.	135.	28+5.	23.	$15\frac{7}{8}$. $2\frac{1}{8}$.	Dr. Jones.
Charleston, S. C.	136.	22+11.	22.	$17\frac{3}{4}$. $2\frac{3}{8}$.	Dr. Barker.
"	135.	30.	23.	$14\frac{1}{2}$. $1\frac{5}{8}$.	"
"	135.	31+5.	22.	$15\frac{1}{4}$. $1\frac{7}{8}$.	"
"	136.	27.	23.	$13\frac{1}{4}$. $1\frac{3}{8}$.	"
"	132.	34.	22.	14. $1\frac{7}{8}$.	"

2. Crotalophorus consors, B. & G.—Twenty-five rows of dorsal scales, all carinated except the two first rows on either side. Seven series of blotches, one dorsal and three on each side, all very small. A yellowish white line passing from behind the nostril below and behind the eye.

Resembles *C. miliarius* in its general appearance, but without the vertebral brownish red line. The ground color is olivaceous brown, the blotches of a deeper brown, encircled with a black fillet margined with a whitish yellow line. There are about fifty blotches in the dorsal series emarginated anteriorly only, thirty of which are transversely elongated, very irregular; the twenty remaining ones nearly circular, with regular outlines. The blotches of the lateral rows are comparatively small and of nearly equal size, though sometimes one of either row may appear much the largest. The blotches of the first lateral series are opposite to those of the dorsal and affect the 1st, 2d, and 3d rows of scales and the extremities of the abdominal scutellæ. The blotches of the second series alternate with these, extending on the 3d, 4th, and 5th rows of scales. The blotches of the third series are obsolete and alternate with those of the second series, and are generally opposite to those of the dorsal series situated in the 5th, 6th, and 7th rows. The upper surface of the head is brown; there are two vittæ extending from the vertex along the neck to the first dorsal blotch. A broader and deep chestnut-brown band extends from the eye to the neck. The frontal region is deeper brown than the vertex. A yellowish white line starts from the nostrils near the upper surface of the head, extending backward in passing between the eye and the pit to the angle of the mouth. A vertical whitish bar extends from each side of the pit to the labial. The belly is yellowish white marbled with black transversely oblong patches. The vertical plate is cordiform; the anterior frontal plates proportionally small; the occipital rather broad. The scales of the body are elongated, a little smaller than in *C. miliarius*, but not quite so acute posteriorly. The two lateral and smooth rows are much broader than the rest and conspicuous: most of the scales of these two rows are black, with the posterior edge straw colored, giving the appearance of a succession of distinct crescents. The tail is conical and tapering; the rattle composed of one ring besides the terminal one.

Indianola. 147. 33. 25. 18½. 2¼. Col. J. D. Graham

3. Crotalophorus tergeminus, Holbr.—Twenty-five rows of dorsal scales, strongly carinated, with the exception of the first row, which is perfectly smooth. Vertical plate subhexagonal, pointed posteriorly. Seven longitudinal series of blotches. A narrow band of yellowish white extends from the pit to the neck in passing close to the angle of the mouth.

Syn. *Crotalus tergeminus,* Say, *Long's* Exp. Rocky Mts. I, 1823, 499.—Harl. Journ. Acad. Nat. Sc. Philad. v. iii, 1827, 372.

Crotalophorus tergeminus, Holbr. N. Amer. Herp. III., 1842, 29. Pl. v.

Crotalophorus, ... Agass. Lake Sup. 1850, 381. Pl. vi. fig. 6–8.

Prairie Rattlesnake, Massasauga.

The ground color above is brown; the blotches are deep chestnut-brown blackish externally, and with a yellowish white margin. The dorsal blotches are thirty-four in number from the head to the region opposite the anus, twenty-six of which are transversely and irregularly oblong, anteriorly and posteriorly emarginated—less so, however, posteriorly; eight are subcircular. Five or six exist on the tail from the anus to its tip, extending on the sides, the last two forming sometimes a complete ring. The next series on either side is composed of small blotches, but as intensely colored as in the other series. They alternate with the dorsal ones. They have no regularity either in outline or position. The second lateral row is composed of the largest lateral blotches. They are transversely oblong or oval on the second, third, fourth, fifth, and sixth rows of scales, and opposite the blotches of the dorsal series; consequently alternating with the third series above. The first lateral series again is composed of blotches intermediate in size between those of the third and second series; they occupy the first and second rows of scales, and extend somewhat to the abdominal scutellæ, and alternating with the adjoining series. Two undulated vittæ extend from the supraorbital plates along the neck to the first dorsal blotch, and often confluent with the latter. A linear vitta margined with yellowish white extends from the posterior edge of the eye to the sides of the neck; the inferior yellow margin is the broadest, and passes from the pit close to the angle of the mouth, turning forward to the middle of the lower jaw, enclosing a semi-elliptical brown patch. Two elongated yellowish spots may be observed diverging from both sides of the pit to the lip. The cephalic plates are deep chestnut brown; a transverse light brown band extends across the head from one orbit to the other.

The color underneath is blackish brown intermingled with yellowish.

Racine, Wisc.	150.	21.+1.	25.	$29\frac{1}{2}$.	$2\frac{3}{4}$.	Dr. Hoy.
Grosse Isle, Mich.	136.	31.	25.	$19\frac{3}{8}$.	$2\frac{3}{8}$.	Rev. Chas. Fox.
Warren Co., Ohio.	141.	29.	25.	$23\frac{3}{8}$.	$3\frac{3}{8}$.	Dr. J. P. Kirtland.

4. Crotalophorus Edwardsii, B. & G.—Twenty-three rows of dorsal scales; first and second lateral row smooth. Vertical plate subpentagonal, tapering posteriorly. Lateral rows of blotches proportionally very small.

The ground-color is yellowish brown with three lateral series of deep chestnut-brown blotches. Two elongated brown blotches extend from the supercilliaries backward. A narrow band of chestnut brown, from the posterior frontal plates, passes over the eyes to the neck, under which a yellowish stripe extends from the nostril to the angle of the mouth. The snout and upper jaw are brown with two yellow fillets diverging from the pit. The lower jaw and chin are mottled with brown and yellow. There are about forty-two dorsal brown and irregular blotches margined with deep black and encircled with a yellow fillet, from the head to the tip of the tail—the 34th opposite the anus—the last three passing to the sides of the tail but do not meet below. Subcircular on the posterior half of the body, the blotches on the anterior half are longer transversely than longitudinally; emarginated anteriorly only.

The blotches of the two lateral series are proportionally small. The blotches of the upper series are more or less obsolete and alternate with the dorsal ones. Those of the second lateral series are the smallest and alternate also, being of as deep a color as the dorsal ones, but do not extend beyond the anus, occupying the second, third, and fourth rows of scales. The first and lower series affect the first and second rows, and only one scale. The belly is of a light straw color, dotted and sprinkled irregularly with brown.

Scales elliptical, subtruncated posteriorly, constituting twenty-three rows, strongly carinated, except the two lateral rows, which are smooth.

Head, when seen from above, subelliptical; vertical plate proportionally more elongated than in *C. tergeminus.*

Tamaulipas.	143.	28.+3.	23.	$17\frac{1}{8}$.	$2\frac{1}{8}$.	Dr. Edwards.
S. Bank of Rio Grande.	153.	24.	23.	11.	$1\frac{5}{8}$.	Gen. Churchill.
Sonora.	145.	26.	23.	$8\frac{1}{2}$.	$1\frac{1}{8}$.	Col. J. D. Graham.

5. **Crotalophorus Kirtlandii**, Holbr.—Twenty-five rows of dorsal scales, sometimes only twenty-four, all strongly carinated except those of the first lateral row. Vertical plate rather short and broad. Color in the adult almost uniformly black, with a vertebral series of dusky brown blotches, sometimes very obsolete. Underneath bluish slate, with the posterior margin of the scutellæ yellowish.

Syn. *Crotalophorus Kirtlandii*, Holbr. N. Amer. Herp. III, 1842, 31, Pl. vi.

Black Massasauga.

The scales of the lateral row are as broad or high as long. Those of the second row are but slightly carinated, and distinguished from the next rows above in being broader and regularly elliptical posteriorly. The carinated scales are elongated, and the narrowest as they approximate the dorsal region. They are posteriorly rounded or subacute.

In the young, eight inches and a half long, the ground-color is brown, with a dorsal series of deep brown spots transversely oblong, emarginated anteriorly and posteriorly, almost quadrangular on the posterior region of the body and tail; and thirty-four in number from head to tail. There are three lateral series of blotches on each side; the upper one composed of small and obsolete blotches, alternating with the dorsal ones; the second row is composed of vertically oblong blotches, larger than those of the upper, and a little smaller than those of the lower series. The latter extend partly on the abdominal scutellæ, as in *C. tergeminus* and other allied species. Six or seven rings to the rattle.

Warren Co., Ohio.	140. 21+5. 24.	23¾.	2½.	Dr. J. P. Kirtland.
"	144. 19+5. 23.	24⅝.	2⅝.	"
"	142. 17+3. 25.	25.	2½.	"
"	143. 15+9. 25.	8½.	⅞.	"

Genus **AGKISTRODON**, Beauv.

Gen. Char. A deep pit between nostril and the eye. Nine plates on top of head. Without rattle. Poison fangs as in *Crotalus*. One pair of occipitals. A loral between the nasal and anterior orbitals. Labials excluded from the orbit by the presence of suborbital plates. Scales carinated; rows 23 in number. Subcaudal scutellæ divided posteriorly. Sometimes a small plate between the vertical and postfrontals. Habits terrestrial.

Syn. *Agkistrodon*, Pal. de Beauv. Trans. Amer. Phil. Soc. Philad. IV, 1799, 381.

1. Agkistrodon contortrix, B. & G.—Loral present. Labials not entering into the orbit. Dorsal rows of scales 23. Color light chestnut, with inverted Y-shaped darker blotches on the sides. Labials yellowish white.

Syn. *Boa contortrix*, Linn. Syst. Nat. I, 273.—Gm. *L.* Syst. Nat. ed. xiii, I, iii. 1788, 1082.

Agkistrodon mokason, Beauv. Trans. Amer. Philos. Soc. Philad. IV, 1799, 380.

Scytalus cupreus, Rafin. Amer. Journ. Sc. I., 85.—Harl. Med. & Phys. Res. 1835, 130.

Trigonocephalus cenchris, Schl. Ess. Phys. Serp. Part. desc., 1837, 553. Pl. xx, fig. 10 and 11.

Trigonocephalus contortrix, Holbr. N. Amer. Herp. II, 1838, 69 Pl. xiv, and 2d ed. III, 1842, 39. Pl. viii.

Copperhead.

More slender than *Toxicophis piscivorus*. Plates on neck and side smaller. Two anterior orbitals, one above the other, the lower narrower, and forming the posterior wall of the pit. A distinct loral between these and the posterior nasal. Labial not forming part of the orbit, but separated by the four post and suborbitals. Labials not so largely developed; 8 above, 3d and 4th largest; 9 below.

Above light hazel brown, rather brighter on the top of the head, and everywhere minutely mottled with very fine dark points. On each side is a series of 15–26 darker chestnut-colored blotches resting on the abdominal scutellæ, and suddenly contracting about the middle of the side, so as somewhat to resemble an inverted Y. These

blotches extend to the vertebral line, where they may be truncated or end in a rounded apex. Generally those of opposite sides alternate with each other, but frequently they are confluent above, forming continuous bands. They are so disposed, that the intervals between the successive blotches are pretty much of the same shape and size, though inverted. The centres of the blotches are lighter; in some cases so much so as greatly to increase the Y-shaped resemblance. Color beneath dull yellowish, with a series of distinct large dark blotches, 35–45 in number, on each side. Chin and throat unspotted. Sides of head cream color; the line of demarcation very distinct; this passes along the upper edge of the head, in front of the eye, and involving the lower three-fourths of the orbit, intersects the middle of the 2d postorbital plate, (counting from above,) and extends along the 1st row above the labials, to the posterior edge of the last labial; the line then comes back through the middle of the lower labial range, where it is marked by a narrow black line. Rostral of the same color. A small areolated dark spot near the inner edge of each occipital plate.

Cleveland.	153.	40+10.	23.	$27\frac{7}{8}$. $3\frac{5}{8}$.	Dr. Kirtland.
"	152.	42+10.	23.	29. $4\frac{3}{8}$.	"
Foxburg, Pa.	152.	32+18.	23.	$26\frac{7}{8}$. $3\frac{3}{4}$.	S. F. Baird.
"	152.	32+18.	23.	$32\frac{3}{4}$. $4\frac{1}{2}$.	"
"	150.	48.	23.	7. $3\frac{3}{4}$.	"
Carlisle, Pa.	154.	42.	23.	$22\frac{7}{8}$. $2\frac{7}{8}$.	
"	154.	48.	23.	$28\frac{1}{2}$. $4\frac{1}{8}$.	"
Charleston.	150.	40+8.	23.	$24\frac{3}{4}$. $3\frac{3}{8}$.	C. Girard.
Prairie Mer Rouge, La.	153.	40+8.	23.	$20\frac{3}{4}$. $2\frac{7}{8}$.	Jas. Fairie.
" "	150.	30+18.	23.	$20\frac{3}{4}$. 3.	"

Blotches larger and fewer, about 15 in number, and running more upon the abdomen. Vertical plate larger and more acute posteriorly.

Bet. Indianola & San Antonio.	150.		23.		Col. Graham.
Sabinal.	150.	31+17.	23.	$11\frac{1}{8}$. $1\frac{5}{8}$.	"

Genus **TOXICOPHIS**, Troost.

Gen. Char. No rattle. Pit and fangs as in *Agkistrodon*. Eleven plates on top of head. No loral plate between nasal and anterior orbital. A second and smaller pair of occipital plates contiguous to the first. Labial entering into the orbit. Scales very conspicuously carinated, forming 25 longitudinal rows. Subcaudal scutellæ divided posteriorly. Habits aquatic.

Syn. *Toxicophis*, Troost, Ann. Lyc. Nat. Hist. N. York, III, 1833, 190.

1. Toxicophis piscivorus, B. & G.—No loral. Inferior wall of orbit constituted by 3d labial: 25 dorsal rows. Dark chestnut brown, with indistinct vertical dark bars. Line from superciliary along the edge of the head, through the middle of the second supra labial row. A second line from the lowest point of the orbit parallel to the first.

Syn. *Trigonocephalus piscivorus*, Holbr. N. Amer. Herp. II, 1838, 63. Pl. xiii. and 2d ed. III, 1842, 33. Pl. vii.
Water moccasin.

Scales all large and well developed; those on the sides and back of head conspicuously so. Two nasal plates with the nostril between them. Anterior orbitals two, one above the other; the upper extending from the eye to the posterior nasal, the lower linear, and forming the upper wall of the pit. Lower and posterior wall of pit constituted by a narrow plate resting along the 3d labial, and terminating on the 2d. Third labial very large, constituting the inferior wall of the orbit, of which three scales form the posterior. Upper labials 8, very large and broad: lower 10. Occipitals terminated each by a triangular plate. All the scales on the back of the head carinated. Dorsal scales all carinated.

General color dark chestnut-brown, with darker markings. Head above purplish black. An obsolete chestnut-brown streak passes from the posterior end of the superciliary along the upper edge of the head, through the middle of the 2d row of supralabial scales. A narrow yellowish white line passes from the 3d labial, or begins just below the lowest part of the orbit, and passing backward, paral-

lel with the first stripe, crosses the angle of the mouth at the 7th labial, and meets the first stripe on the side of the neck, where it is confluent with the yellowish white of the throat. On the lower labial are three short, nearly vertical light bars, on the 4th, 6th, and 7th; the rest of the jaw itself, as well as the interval between the stripes on the sides of the head, dark purplish brown, of which color is also the space in front and below the eyes. General color above dull dark chestnut-brown. On each side a series of 20 or 30 narrow vertical purplish black bars, one or two scales wide. Of these, sometimes two contiguous to each other on the same side are united above into an arch, enclosing a space, the centre of which is rather duskier than the ground-color; at others, corresponding bars from the opposite sides unite and form half rings, encircling the body. Sometimes there is a lighter shade bordering the dark bars. Beneath black, blotched with yellowish white.

Prairie Mer Rouge. 140. 24 + 21. 25. 22¾. 3½. Jas. Fairie.

2. Toxicophis pugnax, B. & G.—No loral plate. Second labial displaced; 25 dorsal rows. Above olive-brown, with narrow transverse dark zigzag bars. Cheeks uniform light colored.

General structure of the plates as in *T. piscivorus.* No loral. Second labial pressed out of place, and with its apex alone on the edge of the mouth. Scales of head smaller than in *T. piscivorus.* Outline different. Lower edge of orbit bordered by parts of two labials.

General color above light olive-brown; beneath yellowish, with a series of indistinct square brown blotches on each side; chin and throat unspotted. Tail entirely black. A series of transverse dark brown zigzag lines are seen crossing the back, involving the entire surface of single scales; these lines are broken up more or less, so as to render the definition of pattern very difficult. Sometimes the band will be indicated merely by a few dark scales on the middle of the back; at others it may be traced to the blotches on the abdomen. Of these blotches there are about 30 from head to anus. The intervals between the bands are much larger than the bands themselves, being from 3 to 6 scales in length. No indication of a dark patch behind the eye, but the cheeks appear yellowish brown, brighter on the labials.

Indianola, Tex. 145. 21 + 21. 25. 36½. 5¾. Col. J. D. Graham.

Genus **ELAPS**, Schn.

Gen. Char. Body slender and cylindrical, never exceeding three or four feet in length. Head somewhat depressed, in most cases continuous with the body; subelliptical in shape, tapering forwards, covered above with plates, generally nine in number. No pit between the eyes and the nostrils. Mouth moderately cleft, not dilatable as in the other serpents. Upper jaw furnished on each side with a small permanently erect fang, situated more posterior than in *Crotalidæ.* The tail is continuous with the body, conical, and tapering towards the tip. Scales smooth; subcaudal scutellæ entirely bifid.

Syn. *Elaps,* Schn. Hist. Amph. Nat. & Lit. 1801, 289.

1. Elaps fulvius, Cuv.—Head oval, posteriorly broader than the neck. Body red, annulated with black rings margined with yellow. Vertical plate pentagonal, rounded anteriorly; its posterior tapering part included between the occipitals.

Syn. *Coluber fulvius,* Linn. Syst. Nat. I, 1766, 381.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1104.

Vipera fulvia, Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 364.

Elaps fulvius, Cuv. Règn. Anim. II, 1817.—Fitz. N. Class. Rept. 1826, 61. —Holbr. N. Amer. Herp. II, 1838, 87. Pl. xviii; and 2d ed. III, 1842, 49. Pl. x.

Harlequin Snake.

The red may be considered as the ground-color of the body, though the black rings occupy nearly as much space above as the red, so as to give the general appearance of a succession of red and black rings. The yellow is intermediate. The anterior part of the head from the posterior point of the vertical plate, embracing the orbits, is black, as is also the tip of the lower jaw. A yellow ring passes across the occipital region down to the inferior surface of the head, embracing the space between the posterior rim of the eye and the angle of the mouth Then comes a black ring, covering eight dorsal scales, margined posteriorly with yellow. From this region to the origin of the tail, the black and red rings from 14 to 19 in number each, alternate, being

separated from each other by a narrow band of yellow. The black rings cover seven entire scales, and two halves; the intermediate red space, five entire scales and two halves; and the yellow either one and two half-scales or two halves only. Some red spaces may occasionally cover nine and ten scales. The tail is alternatively black and yellow; the first caudal ring is black, and embraces ten scales; the second is yellow, and covers three scales. Two black and two yellow succeed and cover the same ground. The tip of the tail is black on five scales. The tip may be either black or yellow, for, according to the size, there are either three or four black rings. Underneath the colors are the same, but dull; occasionally one or more black rings may not surround the body. The reddish spaces are irregularly blotched with deep black, as also sometimes on the upper surface.

Charleston, S. C.	207. 30. 15.	$28\frac{1}{2}$. $3\frac{1}{2}$.	C. Girard.
"	205. 39. 15.	$22\frac{7}{8}$. $2\frac{3}{4}$.	Dr. S. B. Barker.
"	209. 37. 15.	$17\frac{1}{4}$. $1\frac{7}{8}$.	"

2. Elaps tenere. B. & G.—Head narrow, elongated, continuous with the neck and body. Body fawn-colored, annulated with black and yellow. Vertical and occipital plates narrow and elongated.

The ground-color is of a light fawn, dotted with black, annulated with black rings about one-third narrower than the fawn, and with yellow rings about the half of the width of the black ones. The anterior portion of the head is black, from the posterior rim of the eye across the middle of the vertical plate to the mouth, scarcely affecting the tip of the lower jaw. A yellow ring embraces the occipital region from the eyes to the angles of the mouth. There are thirteen black rings from the head to the origin of the tail, and twice as many yellow ones, the fawn-colored rings being equal in number to the black ones. The first black ring covers eight scales. The succeeding ones cover only six, and occasionally the half of the next scale. The yellow rings embrace two entire scales and two halves. The fawn-color intermediate covers nine or ten scales, the last but one only seven or eight, and the last five or six. On the tail the fawn is absent, and two black and two yellow rings alternating cover the whole space. The first of the caudal rings is black, and embraces ten and two half-scales; the yellow coming next, covers four scales; the second black one twelve and two half-scales; the second yellow also

four scales; the extreme tip of tail is black. Underneath, the coloration is the same, with less brilliancy; the fawn-colored rings are maculated with black blotches.

The proportional difference in width between the colored rings constitutes a great difference between this species and *E. fulvius*. It is a much more slender snake, provided with a more slender head, which imparts to the cephalic plates a more elongated shape, especially to the vertical and occipitals. The eyes also are much smaller.

San Pedro of Rio Grande.	237+2.	26.	15.	$17\frac{3}{8}$.	$1\frac{5}{8}$.	Col. J. D. Graham.
New Braunfels, Tex.	230+1.	29.	15.	26.	2.	F. Lindheimer.
"	224+1.	38.	15.	22.	$2\frac{1}{2}$.	"

3. Elaps tristis, B. & G.—Head broad behind, pointed forwards. Vertical plate subpentagonal, equilateral, with its posterior triangular part short and obtuse. Eyes proportionally small.

The affinities of this species are intermediate between *E. fulvius* and *E. tenere*. It has the red-colored ground, annulated with black rings, fourteen in number, and covering five or six scales above, occasionally seven, and only three or four when reaching the outer or lateral rows: thus these rings diminish towards the abdomen. The yellow rings on the other hand have the same width as in *E. fulvius*, embracing one entire row of scales and two halves. The intermediate red spaces affect six or seven scales, dotted all over with deep black, as in the two preceding species. The tail has four black and three yellow rings, the tip being yellow. The first three black ones embrace nine and eight scales, the fourth only six. The intermediate yellow cover three or four scales.

The shape and structure of the head, as given above, are the prominent distinguishing characters.

Kemper Co., Miss.	203.	41.	15.	$17\frac{5}{8}$.	$2\frac{1}{8}$.	D. C. Lloyd.
Rio Grande, W. of San Antonio.	209.	40.	15.	$10\frac{1}{2}$.	$1\frac{1}{4}$.	Gen. Churchill.

GENUS **EUTAINIA,** BAIRD & GIRAR.

GEN. CHAR. Body moderately stout in some species, slenderer in others. Scales carinated. Skin very extensible. Cephalic plates normal. Anterior orbitals 1; posterior 3. Abdominal scutellæ all entire; subcaudal divided. Dorsal rows of scales 19–21. Abdominal scutellæ, 140–170. Subcaudal, 50–120. General color, three light stripes on a darker ground, intervals with alternating or tesselated spots. Abdomen without square blotches. Mostly terrestrial. Many of the species ovo-viviparous.

A. *Body very slender, elongated. Tail very long. Lateral stripe on the third and fourth rows of scales. Dorsal rows* 19.

1. Eutainia saurita, B. & G.—Very slender. Color above light chocolate. Three stripes of uniform yellow. Below the lateral stripes, light brown. Abdomen greenish white. On an average the length of tail is more than one-third the total length.

SYN. *Coluber saurita*, LINN. Syst. Nat. I, 1766, 385.—GM. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1109.—HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 352.—STORER, Rep. Rept. Mass. 1839, 229.—THOMPS. Hist. of Verm. 1842, 115.

Leptophis sauritus, HOLBR. N. Amer. Herp. III, 1842, 21. Pl. iv.—DEKAY, New York Fauna, 1842, 47. Pl. xi, fig. 24.

Riband Snake; Swift Garter Snake.

A broad vertebral line of sulphur-yellow, occupying one and two half-rows of scales, the line margined for half a scale on each side with black. A lateral stripe on each side along the 3d and 4th rows of lateral scales; the scales in the exterior edges of this stripe occasionally speckled or margined with black. Skin between the scales black, with numerous small yellow lines, half a scale long, seen only in dilating the skin. In some specimens the black shows as a series of lateral spots. The usual double spot on the line of union of the occipitals. Orbital plates yellowish white, as are the lower part and sides of the head and throat.

In one specimen from Westport, N. Y., there is a well-defined black line under the lateral stripe.

Carlisle.	156.	115.	19.	35.	12¼.	S. F. Baird.
"	157.	118.	19.	26¾.	9.	"
Washington.	157.	118.	19.	32½.	9.	"
Westport, N. Y.	—	—	—	—	—	"
Lancaster, Mass.	—	—	—	—	—	"
Virginia.	—	—	—	—	—	C. Sanford.

2. Eutainia Faireyi, B. & G.—Body above blackish brown, with three longitudinal stripes of uniform tint. Abdomen greenish white. Stouter than *E. saurita*. Head large. Tail rather less than one-third total length.

SYN. *Tropidonotus saurita?* SCHLEG. Ess. Physiogn. Serp. Part. discr. 1837, 321.

A dorsal stripe one and two half-scales wide, and one lateral on each side on the 3d and 4th row, of the same color, (greenish yellow.) Scales broader and more rounded than in *E. saurita;* head stouter, color different. Differs from *E. proxima*, in having all the longitudinal stripes of the same color; from *E. saurita* in a stouter body, and in having the color below the lateral stripe the same as that above. Body slender, but stouter than in *E. saurita*. The tail is proportionally shorter than in *E. saurita*, but longer than in *E. proxima*.

Prairie Mer Rouge, La.	178.	115.	19.	30½.	10.	Jas. Fairie.
" "	174.	114.	19.	26¼.	8.	"
" "	168.	—	19.	29.	—	"

3. Eutainia proxima, B. & G.—Body stoutest of the division. Black above; three longitudinal stripes, the dorsal ochraceous yellow or brown, lateral greenish white or yellow. Total length about three and a half times that of the tail.

SYN. *Coluber proximus*, SAY in *Long's* Exped. to Rock. Mts. I, 1823, 187. —HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 353.

Deep brown almost black above and on the sides; beneath greenish white. Dorsal stripe on one and two half-rows of scales, ochraceous yellow, lateral stripe on the 3d and 4th rows of scales, greenish yellow or white, markedly different in tint from the dorsal. Sides

of abdominal scutellæ, and 1st and 2d dorsal series of the same color as the back. On stretching the skin, numerous short white lines are visible. Occipital plates with two small approximated spots on the line of junction. Orbitals whitish. The greenish white of the abdomen becomes more yellow anteriorly.

In some specimens from along the Rio Grande the dorsal stripe is ochraceous brown.

Head more like that of *E. saurita* than of *E. Faireyi*, while the body is stouter than in either. The subcaudal scales are less numerous than in the other two allied species. Resembling *E. Faireyi* in color, it is always distinguishable by the stouter body, fewer caudal scales, and dissimilarity of color in the longitudinal stripes.

Red River.	170.	100.	19.	33.	9.	Capts. Marcy & McClellan.
New Braunfels, Texas.	171.	100.	19.	25½.	7¼.	F. Lindheimer.
Near Indianola.	170.	105.	19.	15⅜.	4⅝.	Col. Graham.
" "	178.	108.	19.	19.	5¾.	"
San Pedro, Texas.	169.	105.	19.	14.	4.	"
Sabinal, New Mex.	—	—	—	—	—	"
Medina, New Mex.	—	—	—	—	—	"

B. *Body stouter. Tail shorter. Lateral stripe on the 2d and 3d row of scales.*

1. Dorsal rows 19.

4. Eutainia infernalis, B. & G.—Most slender of all the species of the section. Head and eye large. Above black: a series of about 110 triangular reddish yellow spots, confluent with the indistinct lateral stripe, itself confluent with the greenish white sides and abdomen.

Syn. *Coluber infernalis*, Blainv. Nouv. Ann. Mus. d'Hist. Nat. III, 1834, 59. Pl. xxvi, fig. 3 & 3a.

Aspect colubrine, as indicated by Blainville. A vertebral line of yellowish white, composed of one and two half-rows of scales, on each side of which is a blackish stripe, not encroaching upon the light colored stripe along the 2d and 3d lateral rows of scales. Above the latter the black is interrupted by about 110 subtriangular spots of reddish yellow or reddish white. Abdomen and exterior row of dorsal scales are greenish white, tinged posteriorly with slate. A minute black spot, more or less covered by the incumbent scutellæ

on each side of each abdominal scale, near the extremity. No occipital spot.

The exterior row of dorsal scales is carinated, and larger than the rest, which are about equal. The scales of the slender tail are likewise carinated.

A specimen collected on Sacramento River by the Exploring Expedition is smaller, but very similar. As usual in small specimens, the black is in the form of isolated spots, confluent above, with an olivaceous brown ground.

California.	163.	83.	19.	25½.	6½.	Dr. Wm. Gambel.
Sacramento River.	170.	—	19.	13¾.	3½.	(on dep.) Expl. Exped.

5. Eutainia Pickeringii, B. & G.—Body slender. Black above, slate-color beneath. Lateral stripe irregular, confluent with the light-colored intervals between the dark spots.

This species exhibits great variations in color, principally in regard to the amount of black on the abdomen and the extent of the stripes. The most strongly marked specimen is of an intense black, tinged with bluish below. There is a very narrow greenish white vertebral line, beginning at the nape, where it occupies one and two half-scales, and gradually narrows to the carina of the middle dorsal row, becoming obsolete at the anus. The carinæ of the 2d and 3d rows of exterior dorsal scales show the faint line of greenish white, only perceptible on close observation. The lores, labials, cheeks, and head beneath, greenish white, gradually shading into the blue-black of the abdomen at or about the anterior fifth.

Puget Sound, Or. 158. 73. 19. 26¼. 6½. (on dep.) Expl. Exped.

In another specimen, with the general color very dark, the vertebral line occupies one and two half-scales throughout. The black on each side appears formed by the confluence above of about 76 spots from head to anus, each spot from 1½ to 2 scales long. In other words, there is a stripe of black 3½ scales wide on each side of the vertebral line, confluent with which is a series of black spots on each side, as indicated. The lateral stripe is on the 2d lateral row of scales, of a greenish white color, and confluent with the intervals of the spots also of the same color. The stripe is not well defined, but swells and narrows like a knotted cord. Exterior row of dorsal

scales and sides of abdomen deep blue-black, becoming greenish toward the middle of the abdomen; anteriorly the color shows more white.

Puget Sound, Or.	170. 86. 19.	18. 4½.	(on dep.)	Expl. Exped.

In other specimens the lateral lines are better defined, though always more irregular than usual. Sometimes the color above is more brown than described; inferiorly, however, there is always a slate-blue tint, especially behind.

Puget Sound, Or.	166. 87. 19.	21¼. 5½.	(on dep.)	Expl. Exped.
" "	161. 75. 19.	26. 5¾.	"	"

In this species the inequality between the exterior dorsal row of scales and the rest is inconspicuous. The former is rather the larger, and little or not at all carinated. The second row is about the same size as the rest. The eyes are larger, and the head shorter than in *E. leptocephala*, from the same locality.

Collected by the United States Exploring Expedition, and dedicated to the discoverer, Dr. Charles Pickering.

6. Eutainia parietalis, B. & G.—Above olive-brown: beneath slate-color. Longitudinal stripes greenish. Spaces about and between the dark spots on the sides, brick red, these colors belonging to the skin, not to the scales.

SYN. *Coluber parietalis*, SAY, in *Long's* Exped. to Rock. Mts. I, 1823, 186. —HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 349.

Body apparently more slender than *E. sirtalis*. In many respects resembling *E. Pickeringii*. The only specimen being a stretched skin preserved in alcohol, the colors are somewhat difficult of definition. Above dark olive, beneath light slate-color, except the inferior surface of the head, which is yellowish white. A broad longitudinal dorsal line of one and two half-rows of scales, and an equally distinct one on each side on the second and third dorsal rows, of a greenish slate. The sides of the abdomen and the exterior dorsal row are dark slate-brown. When the skin is stretched, there are seen on each side, between the dorsal and lateral rows, two rows of quadrate black blotches, the first quite distinct, between the third and sixth rows; the second between the sixth and vertebral line, the spots

more or less confluent above with each other, and with those on the opposite side; the blotches about one scale apart. The intervals between the blotches of a vivid brick-red, which color, as well as the black, is sometimes seen on the bases of the adjoining scales. None of the short white lines of *E. sirtalis* are visible. More or less of white on the inferior surface of the tail.

The color when living, as described by Say, is black-brown above, beneath bluish green, head beneath white. A vertebral greenish yellow line, and a lateral pale yellow one: about eighty concealed red spots or semifasciæ on the skin and lateral margin of the scales.

Betw. San Antonio & El Paso. 157. 78. 19. 36. 8½. Col. Graham.

7. Eutainia leptocephala, B. & G.—Scales on the greater portion of tail scarcely carinated. The two exterior dorsal rows on each side unequal, but conspicuously larger than the rest; outer one not carinated. Head slender, plane above. Orbitals 3 posterior; 2 anterior. Above light olive-brown, with distinct small brown spots, 130 in a series from head to anus.

Exterior row of dorsal scales broader than usual, not carinated; second smaller, but also broader than usual, and faintly carinated. Top of head nearly plane from occiput to anterior frontals. Head narrow and depressed. Eyes small. Labials narrow. Scales on sides of anus not conspicuously smaller.

Color dull light olive-brown or light chocolate, beneath pale greenish slate: when the epidermis is removed, the subjacent skin of the abdomen is seen minutely punctured and clouded with black, so as to impart this latter color to the whole, except near the edge. A vertebral dull yellowish line on a single row of scales which appears more prominent than the rest. On each side of this vertebral line are two series of subquadrate black spots, about 130 from head to anus, on about every other scale, or even closer, and showing very conspicuously on the clear ground-color. Bases of all the scales on the sides of the body are more or less black, occasionally showing beyond the incumbent edges. Little or no indication of a lateral stripe. The lower series of black spots is continued in a faint line along the side of the head to the orbit. In one specimen the coloration is less defined, showing a greenish white color above, with tessellated small spots of black.

Puget Sound, Or.	146.	59.	19.	16.	$3\frac{5}{16}$.	(on dep.)	Expl. Exped.
" "	149.	66.	19.	$23\frac{1}{2}$.	5.	"	"
" "	144.	63.	17.	$17\frac{1}{2}$.	$4\frac{3}{8}$.	"	"
" "	148.	—	19.	20.	4.	"	"

8. Eutainia sirtalis, B. & G.—Body among the stoutest of their form. Olivaceous brown above the lateral stripes, sometimes nearly black, beneath them greenish white; dorsal stripe narrow, encroached upon by the spot; lateral stripes not conspicuous; two or three rows of small indistinct spots, often not perceptible, especially the lower: about 70 from head to anus.

Syn. *Coluber sirtalis,* Linn. Syst. Nat. I, 1766, 383.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1107.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 352.—Storer Rep. Rept. Mass. 1839, 221.

Tropidonotus bipunctatus, Schl. Ess. Physiogn. Serp. Part. descr. 1837, 320.

Tropidonotus sirtalis, Holbr. N. Amer. Herp. III, 1842, 41. Pl. xi.

Tropidonotus tænia, Dekay, New Y. Fauna, Rept. 1842, 43. Pl. xiii, fig. 27.

Striped Snake. Garter Snake.

Color above the lateral stripes dark olive, in old specimens dark brown, beneath greenish white. A narrow, rather indistinct vertebral greenish yellow line. Three series of small indistinct spots on each side, of about 70 from head to anus. The first series is along the exterior dorsal row, the spots about two scales apart. This is sometimes entirely wanting. The second series is on the 3d, 4th, and 5th rows from the abdomen; the third upon the 8th and 9th. In many cases the last-mentioned rows have the spots on opposite sides more or less confluent, giving the appearance of a single median series. These rows of spots are sometimes of a dark chestnut-brown, at others nearly black, and often so blended with the olivaceous of the back as to be scarcely discernible. Numerous short white lines visible on stretching the skin.

Although the 1st, 2d, and 3d exterior dorsal rows of scales are colored like the abdomen, yet a lighter shade on the 2d and 3d gives indication of a lateral stripe.

The bases of the abdominal scales on each side near the outer extremities have a black blotch. There is also the usual double spot on the occiput, not areolated. The dark spotting on the sides belongs more or less to the skin between the scales, in some cases merely tinging the edges of the latter.

St. Lawrence Co., N. Y.	157.	—	19.	15.	3¼	Dr. Hough.
Westport, N. Y.	151.	80.	19.	21.	5¼.	S. F. Baird.
Adirondack Mts., N. Y.	146.	—	19.	24½.	—	"
"	151.	—	19.	20½.	—	"
"	148.	—	19.	14½.	—	"
Summerville, N. Y.	—	—	—	—	—	"
Madrid, N. Y.	—	—	—	—	—	"
Grosse Ile, Mich.	—	—	—	—	—	Rev. Chas. Fox.
"	—	—	—	—	—	" "
"	—	—	—	—	—	" "
Androscoggin, Me.	155.	66.	19.	21½.	4⅞.	C. Girard.
Portland, Me.	—	—	—	—	—	Prof. Caldwell.
Clarke Co., Va.	151.	—	19.	26.	—	Dr. Kennerly.
"	160.	56.	19.	18½.	3¾.	"
"	145.	—	19.	10¾.	2½.	"
Centreville, Md.	151.	75.	19.	10⅛.	2½.	S. F. Baird.
Foxburg, Pa.	150.	70.	19.	24.	5¾.	"
"	147.	—	19.	18.	4.	"
Carlisle, Pa.	—	—	—	—	—	"
Abbeville, S. C.	155.	—	19.	11½.	3.	Dr. Barratt.
Anderson, S. C.	—	—	—	—	—	Miss Paine.
Kemper Co., Miss.	139.	60.	19.	29¼.	6.	D. C. Lloyd.
"	138.	—	19.	11½.	—	"
Washington, D. C.	—	—	—	—	—	Col. P. Force.

A very old specimen from Westport, N. Y., (♀) has the dorsal line more conspicuous, but still encroached upon by the black spots, (on the exterior half-row.) Bases of all the scales in the exterior row black. Lateral stripe and exterior row bright yellow, and very conspicuous, brighter than the dorsal stripe. Ground-color dark brown.

Westport, N. Y. ♀ 145. 64. 19. 34. 7. S. F. Baird.

9. Eutainia dorsalis, B. & G.—Dimensions of *E. sirtalis.* Outer rows of dorsal scales emarginate. Color olivaceous. Dorsal stripe broad, yellow, margined with black. A row of spots above the lateral stripe.

A broad dorsal stripe of greenish white very well defined, and covering one and two half-rows of scales, margined on each side for one scale continuously with black. On each side, on the 2d and 3d exterior rows, likewise a broad stripe of the same color. Space be-

tween the stripes bright olivaceous, in which on each side is indistinctly seen a series of rather large spots, about 74 in number from head to anus, and ranged just above the lateral stripe. Abdomen, and below the lateral stripes greenish white, not materially differing from the stripes in color, only rather darker. Sides of abdominal scutellæ, and the upper basal edge of the scales in the exterior dorsal row margined with black. A series of black dots on each side of the abdominal scutellæ at the base. The scales in the exterior dorsal row acutely emarginated, as are some of those in the 2d row.

A specimen collected between Monclova, Mexico, and the Rio Grande, by General Churchill.

Rio Grande, Texas. 166. 81. 19. 25½. 6¼. Gen. S. Churchill.

10. Eutainia ordinata, B. & G.—Olive, with three distinct rows of square dark spots on each side: about 85 from head to anus. Lateral stripe wanting; dorsal, very indistinct.

Syn. *Coluber ordinatus*, Linn. Syst. Nat. I, 1766, 379.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1097.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 349.

Tropidonotus ordinatus, Holbr. N. Amer. Herp. III, 1842, 45. Pl. xii.

Vipera gracilis maculatus, Catesb. Nat. Hist. Carol. II, 1743, 51. LI.

Vipera viridis maculatus, Catesb. Nat. Hist. Carol. II, 1743, 53. LIII.

Garter Snake, or Grass Snake.

General color greenish brown or olive. Vertebral yellowish line more or less inconspicuous. Lateral stripe on the 2d and 3d rows of scales very little evident. In fact it might be almost said to be wanting, but for a faint trace. Three series of small square dark blotches on each side, about 85 in number from head to anus. The first is on the outer row of dorsal scales, involving the edges of the contiguous scales. The second on the 4th row; the third on each side of the dorsal stripe, both like the first, involving the edges of, and intervals between the contiguous scales; indeed, on stretching apart the skin, the black spots are seen to be converted into a network of black along the skin. Beneath greenish white, with spots of black near each end of the abdominal scutellæ. Upper labial plates all prominently edged vertically with black.

This species strongly resembles *E. sirtalis*, especially the spotted varieties. It may, however, be readily distinguished by the three regular series of tessellated black spots on each side, their promi-

nence, and their number, about 85, not 70. The lateral stripe is nearly absent, and the dorsal quite indistinct. The lower row of blotches is below and along the place of the lateral stripes. The occipital black patch is much larger than in *E. sirtalis*, and the labials more margined.

From *E. Marciana*, which it resembles, the want of the light patch behind the mouth, and the different number of dorsal rows will always distinguish it.

Riceboro, Ga.	139. 68. 19.	28. 7.	Dr. Jones.
"	141. 55. 19.	21. 5¼.	"
Georgia.	152. 79. 19.	14. 3½.	Prof. C. B. Adams.

11. Eutainia ordinoides, B. & G.—A dorsal and two lateral stripes. On each side two series of black spots, about 80 in number; between the lower series reddish brown; between the upper olivaceous. Dorsal rows 19–21. Body stouter than most species. Exterior row of dorsal scales the larger, carinated. Remaining scales nearly equal. Caudal scales strongly carinated.

Syn. *Tropidonotus ordinoides*, B. & G.—Proc. Acad. Nat. Sc. Philad. VI, 1852, 176.

A very strongly defined dorsal stripe of a yellowish color, occupying one and two half-scales. A second line less distinct along the 2d and 3d rows from the abdomen. On each side, between the dorsal and lateral stripes, are two series of subquadrate black spots, 80 to 84 in number, arranged alternately, and occupying portions of several scales; the spots in the lower series larger. Intervals between the lower series of spots occupied by reddish brown scales, in shape and color somewhat resembling the dead leaves of the hemlock, (*Abies canadensis*). Intervals between the upper series olivaceous brown, more or less blended with the black. Beneath uniform greenish white, with bases of the scales black, as they are also on the more exterior dorsal rows; this color, however, rarely shows beyond the margin of the incumbent scales.

In one specimen, which is much larger than the others, the dorsal spots form a rather narrow margin to the broad dorsal stripe, and are more or less confluent with the ground-color. Space between the lower row of spots pale reddish. Dorsal scales 19. Ninety spots from head to anus.

The characters are very strongly marked, and easily recognised.

California.	161. 67. 19.	$35\frac{1}{4}$. $7\frac{1}{2}$.	(84 spots)	(on dep.) Expl. Exped.
San Francisco, Cal.	165. 85. 21.	$21\frac{3}{4}$. $8\frac{7}{8}$.		"
"	167. 84. 19.	$28\frac{1}{2}$. $7\frac{1}{4}$.	(80 spots.)	Dr. Leconte.

12. Eutainia radix, B. & G.—General color black, with three narrow gamboge-yellow lines. Lateral rows of scales broader than usual.

The head is shorter than usual with the genus. The exterior row of dorsal scales is very broad, nearly as high as long. The second nearly similar in proportion, (a little longer than high,) but smaller, and yet markedly larger than the third and succeeding rows. Posterior angle of the exterior dorsal scales truncated, with the corners rounded off, a character seen to less extent on the second row. The carination of all the scales is greater than usual, and the whole animal has a rougher appearance.

Color above deep brownish black, on the sides verging to lustrous anthracite black, especially on the exterior dorsal and sides of abdominal scutellæ. Beneath bluish black, with minute mottlings of dull gamboge yellowish, which increasing anteriorly becomes uniform greenish gamboge yellow on the anterior third. A narrow line of black near the posterior edge across each abdominal scutella. A dorsal line of gamboge yellow along the middle of the vertebral row of scales, and one on each side along the 3d lateral row, occasionally involving the lower edge of the 4th row.

There are faint indications of the usual black spots where the epidermis has been lost.

Racine, Wisconsin.	153. 51. 19.	$22\frac{3}{4}$. $4\frac{7}{8}$.	Dr. Hoy.

3. Dorsal rows 21.

13. Eutainia elegans, B. & G.—Resembles *E. proxima*, but belongs to a different section. Black above, light beneath. A broad ochraceous dorsal stripe, with two lateral, greenish white. Dorsal scales 21.

Head very short, broad. Upper labial plates highly developed. Eyes small. Exterior dorsal row of scales largest, delicately carinated, remainder of equal size. Above deep blackish brown. An ochraceous or dark gamboge-yellow dorsal stripe begins at the occiput, and suddenly widening to the width of 3 or 4 scales, contracts gradu-

ally to one and two half-rows, at which it continues to the tail. On each side is a well-defined stripe of greenish yellow along the second and part of the third outer row, and contrasting decidedly in color with the vertebral line. The blackish brown color is strongly defined between the stripes, below them the greenish white sides and abdomen are tinged with brown, (on the exterior dorsal and ends of abdominal scutellæ.) The bases of the scales on the exterior dorsal row are black, which sometimes shows when the scales are separated, though usually covered by the incumbent edges.

The species is readily distinguished from its nearest analogue, *E. infernalis*, by the darker color of the sides, the ochraceous dorsal stripe, smaller head, number of dorsal scales, &c. It has a strong resemblance to *E. proxima* in distribution of color, but is stouter and shorter, and has the lateral stripe on the 2d and 3d rows, not on the 3d and 4th.

El Dorado Co., Cal. 167. 57. 21. 23½. 4½. Dr. C. C. Boyle.

A second specimen, belonging to the Boston Natural History Society, has precisely the same markings, although with but 19 dorsal rows. As usual in young individuals, it has black spots along the sides upon an olivaceous ground, with which they are confluent. Above the lateral stripe are seen from 80 to 90 black spots from head to anus, as well as a series of small ones below the line.

California. 155. 80. 19. 13½. 3¼. Bost. Soc. Nat. Hist.

14. Eutainia vagrans, B. & G.—Above light brown, beneath slate-color. Vertebral light line on a single row of scales. Two series of small black spots, about 100 in number, on each side.

Above light brown; beneath slate-color, (sometimes black,) with the margins of the scutellæ black. A dorsal line occupying a single row of scales, of a dull yellowish color, the tint occasionally running into the marginal row. On each side of this, two series of small black spots occupying generally a single scale, and varying from 95 to 105, from occiput to anus. The upper series is in the 2d row from the vertebral, the lower in the 7th.

Compared with its nearest neighbor, *E. leptocephala*, it differs in having the exterior row of dorsal scales large and carinated, the next

row scarcely if at all larger than the rest. Scales of tail decidedly carinated. Labial plates much developed. It has also 21 rows of dorsal scales, and 106, not 130 spots, in series from head to anus. The head is larger and much arched.

The specimen from Puget Sound, may possibly belong to a closely allied species, though it is much like that from California.

California.	169.	80.	21.	27.	6¼.	(98 spots)	Dr. Gambel.
Humboldt River, Cal.	179.	70–80.	21.	12.	3.	(100 ")	J. S. Bowman.
South of Rio Grande, N. Mexico.	173.	90.	21.	15¾.	4.	(106 ")	Gen. Churchill.
Puget Sound.	161.	53.	21.	12⅜.	2¼.	(on dep.)	Expl. Exped.

15. Eutainia Marciana, B. & G.—Prominent color light brown; a vertebral paler line and one lateral on each side, more or less indistinct. Three series of square black spots on each side, of about 56–60 in each series, from occiput to anus. Sides of head black, with a crescentic patch of yellowish posterior to the labial plates. Three and sometimes four black vittæ radiating from the eye across the jaws. A double white spot with a black margin on the suture of occipital plates.

The markings about the head are generally very constant and distinct. Viewed laterally, we see first the large dark brown patch at the back part of the head, extending as far back as the posterior extremity of the jawbones. In the anterior part of this patch is seen the crescentic patch (concave before) of yellowish white, with a more or less narrow dark-brown margin anteriorly. The next black band starts from the posterior edge of the superciliaries, and passes obliquely downwards and backwards along the posterior edge of the 6th upper labial. Similar black margins are seen on the posterior edges of the 5th and 4th labials, the intervening spaces being yellowish white, particularly on the 5th upper labial. Occasionally the posterior margins of the 7th and 3d labials have the black line as well as those mentioned, which frequently extend across to the posterior margins of the corresponding lower labials. The white spot on the anterior portion of the occipital suture is always margined with black.

The six series of black spots are arranged so as to alternate with each other. The lower or third series on each side is below the indis-

tinct lateral stripe. The posterior edges of each abdominal scutella shows a black margined spot on each side. The dorsal line is generally a single scale in width, occasionally including portions of the lateral, and itself sometimes encroached upon by the black spots. Each spot is about a scale or a scale and a half long, and about three scales broad. The number in the dorsal series from the head to the anus varies from 56 to 60. Posterior edges of scales very slightly emarginate, if at all. All are decidedly keeled.

Red River, Ark.	152.	75.	21.	34.	8.	56 spots.		Capts. Marcy & McClellan.
New Braunfels, Tex.	153.	75.	21.	16.	$4\frac{1}{8}$.	60	"	F. Lindheimer.
"	153.	73.	21.	$21\frac{1}{4}$.	$5\frac{1}{4}$.	60	"	"
"	149.	61.	21.	$16\frac{3}{4}$.	$3\frac{1}{2}$.	56	"	"
"	152.	71.	21.	$10\frac{3}{8}$.	$2\frac{3}{8}$.	54	"	"
Near San Antonio.	163.	53.	21.	$20\frac{5}{16}$	$3\frac{1}{2}$.	58	"	Col. J. D. Graham.
"	160.	85.	21.	$27\frac{3}{8}$.	$6\frac{1}{2}$.	56	"	"
San Pedro.	156.	78.	21.	$12\frac{5}{8}$.	$3\frac{1}{6}$.	56	"	"
"	153.	70.	21.	$14\frac{1}{8}$.	$3\frac{3}{8}$.	56	"	"
Indianola.	145.	66.	21.	$11\frac{3}{4}$.	$2\frac{1}{2}$.	57	"	"

Genus **NERODIA**, Baird & Girard.

Gen. Char. Body generally stout, and almost all the species attaining a large size. Tail one-fourth or one-fifth of the total length. Scales carinated. Cephalic plates normal. Anterior orbitals generally 1, occasionally 2; posterior 3, occasionally 2. Last and sometimes penultimate abdominal scutellæ bifid; subcaudal, all bifid or divided. Dorsal rows of scales 23–29. Abdominal scutellæ 133–154. Subcaudal 66–80. General color, three series of dark blotches on a lighter ground, sometimes almost uniform, brown or blackish. Abdomen unicolor or maculated. Habits aquatic.

1. Nerodia sipedon, B. & G.—Head rather narrow, elongated. One anteorbital; three postorbitals. Vertical plate smaller, and occipitals larger than in *N. fasciata*. Length of vertical equal to commissural line of occipitals. Inframaxillary plates extending near to posterior extremity of seventh lower labials. Dull brown, with narrow transverse light bands margined with black. Dorsal rows 23.

Syn. *Coluber sipedon*, Linn. Syst. Nat. I, 1766, 379.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1098.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 351.—Thomps. Hist. of Verm. 1842, 118.

Coluber pœcilogaster, Max. Wied. Reise Inn. Nord. Amer. I, 1839, 106.

Tropidonotus sipedon Holbr. N. Amer. Herp. III, 1842, 29. Pl. vi.

Water Snake.

General color dull brown, exhibiting narrow transverse bands of lighter, margined with dark brown or black; these bands generally about half a scale in width, and their margins more or less parallel immediately on the back. This is especially the case posteriorly, where they are usually at right angles to the axis of the body; anteriorly they are more or less oblique, and widen rapidly towards the abdominal scutellæ. Sometimes the general brown hue is so predominant as to render the transverse marks more or less obsolete, and the general tint then appears uniform above. The abdomen is always dull yellowish, each scutella with large blotches of light brown, margined with black.

In young individuals, and those generally in which the epidermis has been removed, the normal type of coloration is seen to consist of three series of nearly quadrate dark-brown spots, with still darker border, one dorsal, and one on each side. These are so disposed that the two corresponding lateral spots are opposite the interval between the two dorsal, and thus appear to be connected by a light line. The longitudinal diameter of the dorsal spots, amounting to 3 or 4 scales, is the greater, just the reverse of what is the case with the lateral. Of these lateral spots there are generally about 32 on each side from the head to the anus, the spaces between them being equal to or less than the spots, (not greater, as in *N. fasciata*).

While this pattern is generally quite distinguishable on the posterior half of the body, anteriorly it becomes confused, the lateral blotches standing opposite to the dorsal, and becoming confluent, so that the back appears crossed by lozenge-shaped blotches extending to the abdominal scutellæ, and thus separated on the sides by triangular intervals of a lighter color.

Occasionally the color appears to be a dull and rather light brown, with the back crossed by narrow transverse lines, with dark (nearly black, but still not distinct) margins.

Small specimens from Framingham and Westport show a larger amount of black on the sides and abdomen.

Carlisle, Pa.	142+1.	68.	23.	35.	8½.	S. F. Baird.
"	142+1.	—	23.	—	—	"
"	143+1.	66.	23.	—	—	"
"	136+1.	75.	23.	12.	3¼.	"
"	143+1.	67.	23.	9.	2¼.	"
"	137+1.	75.	23.	27½.	7¼.	"
"	140+1.	71.	23.	14½.	3½.	"
"	141+1.	80.	23.	26.	7¼.	"
Westport, N. Y.	140+1.	70.	23.	16.	4.	"
Centreville, Md.	136+1.	62.	25.	—	—	"
Washington, D. C.	138+1.	62.	23.	35.	8.	"
Framingham, Mass.	—	—	—	—	—	"
Grosse Isle, Mich.	143+1.	—	23.	27.	5⅞.	Rev. Chas. Fox.
"	142+1.	59.	23.	24.	5⅛.	"

2. Nerodia fasciata, B. & G.—Head broader behind, and deeper than in *N. sipedon;* hence a greater development of labials, temporals, lorals, and nasals. Three and sometimes only two postorbitals. Vertical plate

pentagonal, broad. Transversal lozenge-shaped or oblong black patches on the back, tapering on the sides. About thirty oblong or triangular marks of red on the flanks. Dorsal rows of scales 23, sometimes 25.

SYN. *Coluber fasciatus*, LINN. Syst. Nat. I, 1766, 378.—HOLBR. N. Amer. Herp. I, 1838, 93. Pl. xx.

Coluber porcatus, HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 356.

Tropidonotus fasciatus, HOLBR. N. Amer. Herp. 2d ed. III, 1842, 25. Pl. v.

Head elliptical, tapering on the snout. Dorsal rows of scales 23–25, all carinated; carinæ on the dorsal region very conspicuous. Scales on the outer row broad and rounded posteriorly. Tail one-fourth of total length, very much tapering. Vertical plate elongated, pentagonal, posterior triangular portion obtuse. Superciliaries very narrow. Two postorbitals and sometimes three. Superior labials 8 in number; 6th and 7th very large. Inferior labials 9; 4th and 5th largest. Last abdominal scutella divided. A large temporal shield anteriorly contiguous to the postorbitals.

Ground-color above in the adult uniform blackish brown, lighter in the young, which exhibit transverse lozenge-shaped black patches irregularly tapering on the sides. There are from 30 to 38 subtriangular or vertically oblong red spots extending to the abdominal scutellæ. The 26th of these red markings is opposite to the anus, and twelve smaller ones may be observed along the tail, gradually diminishing posteriorly. A black vitta extends from the posterior rim of the eye to behind the angle of the mouth, above and below which a light elongated patch tinged with red may be seen. Underneath reddish white. Labials dusky, margined with reddish brown.

Charleston, S. C.	132+1. 70. 25.	28. 7.	Dr. Barker.
"	130+1. 41. 23.	40. 6½.	Acad. Nat. Sc.
Summerville, S. C.	128+1. 75. 23.	21. 5¼.	C. Girard.

3. Nerodia erythrogaster, B. & G.—Head elongated, narrowing forwards; occipital region flattened; convex on the snout. Vertical plate pentagonal, very large, as are also the occipitals. Three postorbitals. An elevated loral. Dorsal rows of scales 23 in number, all very strongly carinated. Uniform dark bluish black above, lighter on the sides; a lateral or external band of dull blue extending on the abdominal scutellæ. Body beneath uniform dull yellow, tail bluish.

SYN. *Coluber erythrogaster*, SHAW, Gen. Zool. III, 1804, 458.—HOLBR. N. Amer. Herp. II, 1838, 91. Pl. xix.

Tropidonotus erythrogaster, Holbr. N. Amer. Herp. 2d ed. III, 1842, 33. Pl. viii.

Vipera ventre cupreo coloris, Catesb. Nat. Hist. Carol. II, 1742, 46. Tab. xlvi.

The head is proportionally narrow and elongated, flattened above, and convex on the snout. The vertical plate is elongated and subpentagonal, broader anteriorly than posteriorly, with the sides slightly concave. The postorbital plates, proportionally small, are three in number. Loral large and polygonal, higher than long. There are three or four temporal shields very much developed. Dorsal rows of scales 23 or 24 in number, strongly carinated, with the keels on the posterior third of the body, constituting very conspicuous and continuous ridges, the intermediate depressions or furrows giving to the body and tail a canaliculated appearance. The lateral or outer row, however, is but slightly carinated. The tail itself is subconical, very much tapering, forming one-fourth of the entire length.

The color, as taken from life, is said to be brick-red above, tinged with green on the sides, and uniform copper-color beneath.

Prairie Mer Rouge, La.	154+1.	80.	24.	44.	11¼.	Jas. Fairie.
Carolina.	149+1.	—	23.	50¼.	—	(on dep.) Acad. Nat. Sc.

4. Nerodia Agassizii, B. & G.—Dorsal rows of scales 23, carinated except the outer row, which is entirely smooth. A second very small anteorbital; postorbitals three. Color uniform reddish brown above, with obsolete transverse narrow light bands under the epidermis; yellowish beneath.

The vertical plate is proportionally more contracted on the sides than in any of the species of this genus, and also more tapering. The occipital plates are broad and proportionally large. The eyes are rather small, resembling in that respect those of *N. taxispilota*, the latter differing however greatly from it in being provided with five more rows of dorsal scales; the scales of the outer dorsal row are proportionally large and perfectly smooth, while these are keeled in the other species. The number of subcaudal scutellæ could not be ascertained, as the only specimen at our command is destitute of a tail. The two last abdominal scutellæ are bifid.

The color, though uniform in the adult, in the immature state is blotched, as in other species of this genus; judging from the trans-

verse narrow light bands that may be seen on the back when the epidermis is removed.

Lake Huron.	147+2.	— 23.	24.	—	(on dep.) Prof. Agassiz.

5. Nerodia Woodhousii, B. & G.—Dorsal rows of scales 25, carinated. Three series of subquadrate black blotches, a dorsal and two lateral, the latter vertically elongated. A double yellow occipital spot. A yellow spot between the superciliaries and vertical plates. A black vitta from posterior rim of eyes to angle of mouth.

The head is broad behind, and tapers forwards, very much flattened above. The mouth is very deeply cleft. The labials are nine above and eleven below; the 5th, 6th, and 7th the largest on both jaws.

Ground-color dusky, with a dorsal series of subquadrangular black blotches, 37 to 40 in number, separated by a narrow whitish transverse line. A lateral series of vertically elongated black blotches, alternating with the dorsal series, with anterior and posterior margins nearly parallel, sometimes tapering downwards and reaching the abdominal scutellæ. The fuscous space between the lateral blotches is wider than that occupied by the blotches themselves. Along the tail, both the dorsal and lateral blotches are small and subcircular. Underneath the color is yellowish, and the scutellæ in the young, margined posteriorly with black, while in the adult the middle region of the scutellæ is unicolor. The head is brownish black, with a double yellow spot near the commissure of the occipital plates, and two spots of the same color on the commissural line between the vertical and superciliaries. A black vitta extends from the posterior rim of the eye to the angle of the mouth.

Indianola.	144+1.	—	25.	27¾.	—	Col. J. D. Graham.
Betw. Ind. & San Antonio.	144+1.	64.	25.	10½.	2⅜.	"
"	142+1.	79.	25.	11.	2⅞.	
Sabinal, Tex.	144+1.	68.	25.	13.	3.	"
New Braunfels, Tex.	148+1.	68.	25.	34.	7¼.	F. Lindheimer.
"	147+1.	72.	25.	25.	6¾.	"
"	145+1.	70.	25.	17.	4¼.	"

6. Nerodia taxispilota, B. & G.—Head proportionally small, subtriangular, pointed on the snout. Vertical plate broad, subquadrangular; occipitals small. Two postorbital plates; anteorbital narrow. Dorsal rows of scales 29, all carinated. Brown, with three series of subquadrangular blackish blotches.

Syn. *Coluber taxispilotus*, Holbr. N. Amer. Herp. II, 1838, 113. Pl. xxv. *Tropidonotus taxispilotus*, Holbr. N. Amer. Herp. 2d ed. III, 1842, 35. Pl. viii.

The head is proportionally small, conical forwards. The eyes also are small. The vertical plate has the shape of an elongated quadrangle. The occipital plates are rather small and posteriorly attenuated. The anterior frontal plates are small and triangular, the apex of the triangle being directed forwards. There are two large postorbital plates. The superciliaries are narrow and elongated. Dorsal rows 29; their scales all carinated.

Ground-color reddish brown, with three series of subquadrangular blackish blotches, forty-six in number, the twenty-sixth opposite the anus. They embrace transversely from 7 to 10 rows of scales, and longitudinally three scales on the two anterior thirds of the body, and two scales on the posterior third. The space between the blotches is equal to the blotches themselves. The lateral series are isolated, that is to say, not contiguous to the dorsal series except sometimes towards the origin of the tail and along the latter region. The blotches extend over nine or ten lateral rows of scales, and affect from three to five scales. Equilateral on the anterior part of the body, they become narrower on the posterior part, and taper upwards. The space between is narrower by one scale. On the tail the dorsal series of blotches has almost entirely disappeared; now and then an irregular patch may be seen confluent with the lateral series, which remain conspicuous to the very tip of that organ. The lower surface of the body is yellowish white, with irregular deep chestnut-brown patches, the lateral ones contiguous to the lateral series.

Riceboro, Liberty Co., Ga. 141+1. 80. 29. 36. 9. Dr. W. L. Jones.

7. Nerodia Holbrookii, B. & G.—Head ovoid or elliptical, narrowest on the snout. Vertical plate much longer than in *N. taxispilota*. Occipitals much larger also. Three postorbitals. Loral higher than long. Dorsal scales in 27 rows, all strongly carinated. Brown, with three series of quadrangular black blotches, the blotches of the lateral series alternating with those of the dorsal.

Head and eyes proportionally larger than in *N. taxispilota.* Vertical plate subpentagonal, and more elongated than in *N. taxispilota.* Occipital plates also much more developed and broader. Inframaxillary longer. Proportion between the length of the tail and that of the body about the same as in *N. taxispilota.* The rows of scales 27 in number, and carinated; the scales themselves proportionally much larger than in *N. taxispilota.* The lateral row especially differs much in that respect.

Ground-color reddish brown, with three series of black subquadrangular blotches, forty-one in number, the twenty-fifth opposite the anus. They embrace transversely six or seven rows of scales, instead of seven or ten as in *N. taxispilota.* Longitudinally they cover three scales on the anterior portion of the body, and two posteriorly as in *N. taxispilota.* The intermediate space, however, is greater than the blotches themselves, embracing one scale more. The lateral series are contiguous to the dorsal one, and alternate regularly with it. The blotches extend on seven lateral rows, embracing three scales, while the intermediate space embraces four of them. Beneath yellowish white, with small and irregular brown blotches scattered along the sides.

Prairie Mer Rouge, La.	144+1. 70. 27.	35. 8.	Jas. Fairie.
"	141+1. 63. 27.	33. 7.	"

Genus **REGINA**, Baird & Girard.

Gen. Char. Body slender; tail subconical, very much tapering, forming one-third or one-fourth of the total length. Head conical, continuous with the body, and proportionally small. Eyes large. Mouth deeply cleft. Labials small. Loral and nasals large. Scales carinated. Cephalic plates normal. Anterior orbitals 2, occasionally one; posterior 2, occasionally 3. Last and sometimes last but one abdominal scutellæ bifid or divided. Subcaudal scutellæ all divided. Dorsal rows of scales 19–21. Abdominal scutellæ 132–162. Subcaudal 52–86. General color five or more longitudinal dark bands on a lighter ground. Abdomen unicolor, or likewise provided with similar bands. Aquatic.

1. Regina leberis, B. & G.—Chestnut-brown, with a lateral yellow band, and three narrow black dorsal vittæ. Abdomen yellowish, with four brown bands, two of which are lateral and two medial. Dorsal rows of scales 19, all carinated.

Syn. *Coluber leberis*, Linn. Syst. Nat. ed. x, I, 1766, 216.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1086.—Shaw Gen. Zool. III, iii, 1804, 433.

Coluber septemvittatus, Say, Journ. Acad. Nat. Sc. Philad. IV, 1825, 240.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 355; and Med. & Phys. Res. 1835, 118.

Tropidonotus leberis, Holbr. N. Amer. Herp. IV, 1842, 49. Pl. xiii.—Dekay, New York Fauna, Rept. 1842, 45. Pl. xi, fig. 23.

Head small, very much depressed, flattened on the region behind the orbit, sloping anteriorly. Vertical plate pentagonal, proportionally broad. There are two anteorbitals, the upper one the larger; and two postorbitals, the upper one the smaller. The loral is large and higher than long. One temporal shield only. Upper labials, 8; 6th and 7th largest. Lower labials 10; 5th and 6th largest. Scales regularly elliptical, slightly notched posteriorly, and all of them carinated, gradually diminishing in width from the sides towards the middle line of the back. Those of the outer row one-third broader than the rest, and posteriorly subtruncated.

Ground-color dark chestnut or chocolate-brown above, marked with three narrow black vittæ or bands, one covering the medial row of dorsal scales, and two (one on each side) following the fifth row. A lateral yellow band occupies the upper half of the outer row and the whole of the second row, thus broader than the black bands above. Immediately below, and contiguous to it, a somewhat larger brown band covers the lower half of the outer row of scales and the extremity of the abdominal scutellæ. The abdomen is yellowish, provided along its middle region with two approximate brown bands, similar though a little narrower, and interrupted by the yellowish edge of the scutellæ. The tail beneath is almost rendered uniformly brown by the confluence of the bands.

Carlisle, Pa.	144+2. 81. 19.	$23\frac{1}{4}$. $6\frac{1}{8}$.	S. F. Baird.
"	142+1. 86. 19.	$21\frac{3}{8}$. $6\frac{3}{8}$.	"
"	142+1. 71. 19.	$14\frac{1}{2}$. $3\frac{5}{8}$.	"
"	145+1. 78. 19.	$9\frac{7}{8}$. $2\frac{5}{8}$.	"
"	140+1. 75. 19.	$8\frac{3}{8}$. $2\frac{1}{4}$.	"
Foxburg, Pa.	151+1. — 19.	23. —	"
Grosse Isle, Mich.	147+1. 64. 19.	$18\frac{3}{4}$. $4\frac{3}{8}$.	Rev. Chas. Fox.
Highland Co., Ohio.	149+1. 76. 19.	$11\frac{3}{8}$. $2\frac{3}{4}$.	Jos. M.D.Mathews
Washington, D. C.	141+1. 81. 19.	$11\frac{1}{2}$. $2\frac{1}{2}$.	(on dep.) Nat. Inst

2. Regina rigida, B. & G.—Greenish brown above; two deep brown vittæ along the dorsal region. Contiguous edges of the outer row of scales and abdominal scutellæ finely margined with brown. The middle region of the outer row like the abdomen, as is that of the second row, but less distinctly. Abdomen reddish yellow, with two series of black spots on the middle region, approaching each other towards the anterior region of the body. Dorsal rows of scales 19, carinated except the outer row, which is smooth.

SYN. *Coluber rigidus*, SAY, Journ. Acad. Nat. Sc. Philad. IV, 1825, 39.—HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 355; and Med. & Phys. Res. 1835, 118.

Tropidonotus rigidus, HOLBR. N. Amer. Herp. III, 1842, 39. Pl. x.

Head proportionally larger than in *R. leberis*, much less depressed and shorter on the snout. Its upper surface is flat, the snout convex, the high and large rostral making it less sloping. Vertical plate subhexagonal and elongated. Occipitals truncated posteriorly. Superciliaries narrow and tapering forwards. Anterior pair of frontals very small. Two postorbitals of nearly equal size, and two ante-

orbitals, the upper one much larger than the lower. Loral subcircular or oblong. An elongated and narrow temporal shield, followed by two or three smaller. Upper labials 7, 5th and 6th very large. Lower labials 11, 6th and 7th largest. Scales elliptical, narrower along the middle line of the back, carinated, except the outer row, which is perfectly smooth, and furthermore distinguished by the scales having their height greater than their length. The second row is noticeable for its size, and sometimes for its want of carination, which in all cases is obsolete.

The ground-color is uniform greenish brown, but each scale on the flanks is provided with a small blotch of deeper brown at its base. The brown vittæ of the back cover each one entire row, and the half of the two adjoining rows, separated on the dorsal line by one row and two half-scales of the ground-color. Beneath dull yellowish. Along the middle region of the abdomen there are two series of elongated deep brown blotches approaching each other towards the anterior region and under the tail, sometimes however not extending beyond the anus.

Southern States.	135+1. 71. 19.	12¾.	3¼.	Rev. Dr. J. G. Morris.
Riceboro, Ga.	135+1. 56. 19.	7¼.	1½.	Dr. W. L. Jones.
Pennsylvania.	132+1. 52. 19.	21.	4.	(on dep.) Acad. Nat. Sc.

3. **Regina Grahamii**, B. & G.—Brown, with a dorsal light band margined on either side with a black line or vitta. A broad band of yellow on the flanks, margined likewise with a black vitta. Abdomen unicolor, yellowish. Dorsal rows of scales 20, all carinated.

Head elongated, slender, depressed, and flattened above, slightly sloping on the snout. Occipitals elongated and posteriorly pointed. Vertical plate subpentagonal, narrower anteriorly. Superciliaries proportionally well developed, as also the anterior pair of frontals. Two anteorbitals, lower one a little the larger. Three postorbitals, the lower one very small and almost suborbital in its position. Loral elevated. Rostral well developed. Upper labials 7, 5th and 6th largest. Lower labials 10, 5th and 6th largest. Dorsal rows of scales 20, all carinated. The three outer rows sensibly the largest, and truncated posteriorly, while the remaining ones are tapering.

A light-brown band along the dorsal line, covering one and two half-rows of scales. On each side of this a narrow black vitta covering one and a half scales. Next succeed three rows of scales, uni-

formly brown. Then again, a black vitta covering an entire row of scales, and the edge of the row immediately under it, (the third.) The first, second, and most of the third outer rows of scales are straw-color. This yellowish band extends forwards, passing under the head to the extremity of the snout. A black line is seen running from behind the neck to the anus, affecting the extremity of the scutellæ, and occasionally the lower edge of the outer row of scales. The abdomen is uniform light straw-color; a medial nebulous blackish band under the tail is observable.

Rio Salado, Tex. 161+1. 57. 20. 10¾. 2. Col. J. D. Graham.

4. Regina Clarkii, B. & G.—Yellowish brown, with four longitudinal bands of deeper brown. Abdomen dull yellow, with two clouded brown bands dotted with black. One anteorbital. Dorsal rows of scales 19, all carinated.

This is the largest species of the genus. Head elongated, conical from occiput to the extremity of the snout, depressed above, subconcave on the occipital region, slightly sloping on the snout. Cephalic plates very much developed. Vertical subpentagonal, broader anteriorly, though slightly tapering. Anterior pair of frontals quite large. Three and sometimes only two postorbitals, variable in comparative size; when there are three, the lowermost is suborbital. One anteorbital, large. Loral well developed, longer than high. Upper labials 8, 5th and 6th largest, the latter very large. Scales of the body elliptical, rounded posteriorly. Outer row somewhat larger than the rest, and very slightly carinated.

Color of head dirty brown, occipital and temporal region blackish. Each of the four longitudinal bands of deep brown covers two rows of scales. The intermediate yellowish brown spaces embrace each two rows of scales also, except the dorsal one, which has three rows. Each of the abdominal clouded bands embraces one-fourth of abdominal space, inside of which is left a yellow space one-fourth of the width, and exteriorly another yellow space one-eighth of the width of abdominal space. The tail beneath is blackish, owing to the confluence of the abdominal bands, interspersed with yellowish maculæ.

Indianola.	132+1.	57.	19.	31¾.	6½.	Col. J. D. Graham.
"	—	—	—	—	—	"
"	—	—	—	—	—	"
"	—	—	—	—	—	"

Genus **NINIA**, Baird & Girard.

Gen. Char. Head elongated, ovoid, distinct from the body. Cephalic plates normal. Two nasals. A large loral produced into the orbit between the anteorbitals, which are two in number. Two postorbitals. Scales all carinated. Subcaudal scutellæ bifid.

Ninia diademata, B. & G.—Body above deep chestnut; on the middle of each scale an elongated yellowish spot. A yellow occipital blotch Abdomen yellowish, with a medial brown band. Dorsal scales in 19 rows.

The vertical plate is hexagonal, as broad anteriorly as long; anterior angle very obtuse; posterior angle acute. The occipitals are very much developed, rounded exteriorly and posteriorly, angular anteriorly. The postfrontals are likewise remarkable for their great development; they are obtusely quadrilateral, being somewhat longer than broad. The prefrontals are proportionally reduced, angular, broader outside. The rostral is broad and well developed. The nostril opens through the middle of the posterior margin of the prenasal, and is seen from above; the postnasal is subquadrilateral, higher than long. The loral occupies a large portion of the face; it is angular in shape, and behind extends to the orbit between the anteorbitals. The lower anteorbital is subtriangular, resting on the 4th upper labial, contiguous to the commissure of the 3d; the upper anteorbital is regularly quadrangular, and visible from above. There are two postorbitals, subquadrangular in shape. The superciliaries are rather small, narrow, and elongated. Anterior temporal shield very large, the rest resembling scales. The eyes are proportionally large and circular. The mouth deeply cleft. Upper labials 6; 5th largest. Lower labials 6; 4th largest.

Body subcylindrical, deeper than broad; tail very slender and tapering, about one-third of the total length. The scales are all carinated, and constitute 19 rows, the outer row considerably larger, the rest diminishing towards the back. Postabdominal scutella appa-

rently entire; the shrunken state of the specimen did not allow a satisfactory examination to be made.

The ground-color of the head and body above is a deep chestnut. On the posterior part of the head is a yellow ring, sending a narrow stripe along the upper labials to the orbit. Each scale is provided on its middle with a narrow and elongated yellow dot, very conspicuous on the outer row of scales, giving at first the impression of a narrow vitta along the sides. The exterior edge of the abdomen is of the same color as the back. The abdomen is yellowish; a medial chestnut band extends from the head to the tip of the tail, interrupted only by the narrow yellowish margin of the scutellæ themselves.

Orizaba, Mex.	136. — 19.	$8\frac{5}{8}$.	$2\frac{3}{4}$.	Jas. Fairie.

Genus **HETERODON**, Pal. de Beauv.

Gen. Char. Body short, stout, tail short. Head, neck, and body capable of excessive dilatation. Posterior palatine teeth longer. Head broad, short; outline of mouth very convex, on a single curve. Orbit enclosed by a continuous chain of small plates, the circle completed above by the superciliaries. Rostral prominent, its anterior face very broad, and turned up; its ridge above sharp. Behind it a median plate, either in contact with the frontals or separated by small plates. Frontals in two pairs. Nasals two. Loral one or two. Dorsal rows of scales 23–27, carinated: Abdominal scutellæ 125–150, posterior bifid. Subcaudal scutellæ all bifid.

Colors light, with dorsal and lateral darker blotches, or else brown, with dorsal transverse light bars. Sometimes entirely black.

The species exhibit a very threatening appearance when alive, in flattening the head, hissing violently, &c. but are perfectly harmless.

Syn. *Heterodon*, Pal. de Beauv. in *Latr.* Hist. Nat. des Rept. IV, 1799.

A. *Azygos behind the rostral, in direct contact with the frontals*

1. Heterodon platyrhinos, Latr.—Occipitals and vertical longer than broad, about equal in length. Centre of eye anterior. Dorsal rows 25, all carinated, the outer sometimes smooth. Keels of the scales extending to their tips. Scales on the back quite linear anteriorly, posteriorly they are much broader. Color yellowish gray, or brown, with about 28 dark dorsal blotches from head to anus, and 15 half-rings on the tail. One or two lateral rows. Beneath yellowish. A dark band across the forehead in front of the vertical, continued through the eye to the angle of the mouth.

Syn. *Coluber heterodon*, Daud. Hist. Nat. Rept. VII, 1799, 153. Pl. lx. fig. 28.—Say, Amer. Journ. of Sc. I, 1818, 261.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 357; and Med. & Phys. Res. 1835, 120.

Heterodon platyrhinos, Latr. Hist. Nat. Rept. IV, 1799, —— 32, fig. 1–3. —Holbr. N. Amer. Herp. II, 1828, 97. Pl. xxi; and 2d ed. IV, 1842, 67. Pl. xvii.

Hog-nose Snake; Blowing Viper.

Vertical plate hexagonal, narrower behind; longer than broad; angles all distinct, lateral outlines straight. Postfrontal large, the lateral angle extending down to the loral; the two postfrontals separated anteriorly by the azygos or postrostral. Prefrontals smaller, entirely separated by the azygos. Rostral with the outline spherical angled, subacute at the apex, its upper surface compressed into a sharp ridge, which, prolonged backwards between the nasals and the prefrontals, connects with the azygos. This is linear, subpentagonal, acute-angled behind, where it wedges between the postfrontals. Superciliaries large. Scales behind the head distinctly carinated. Eye large. Line connecting tip of rostral with the postinferior corner of the last labial passes over the lower part of the eye. A triangular nasal, with the corners rounded, joined by its apex to the exterior angle of the postfrontals. Nostrils valvular, situated entirely in the posterior nasal, the anterior edge formed by the anterior nasal. Labials 8 above, 6th largest, the 3d to the 6th in contact with the suborbitals: two large temporal shields above the three posterior labials. Centre of the eye anterior to the middle of the chord connecting the apex of rostral and posterior end of labials and over the middle of the 5th labial. Outline of upper jaw convex. Lower labials eleven.

Body stout and short. Tail very short, and rapidly tapering, rather thicker than the thinnest part of the body. Dorsal rows 25. Scales all distinctly carinated, (including those on the back of the head,) except the outer row, which is either perfectly smooth, or presents very obsolete carination. The ridges on the 2d row much less distinct than the rest.

Color reddish brown above, with dark blotches. A series of 28 quadrate, dorsal, uniform black blotches from head to anus, each from 2 to 3 scales long, and 7 to 9 wide, separated by regular brownish yellow intervals of 1½ to 2 scales. The blotches anteriorly are nearly square, posteriorly they are transversely elongated. Opposite the intervals, and, indeed, bounding them on either side, is a second series of small circular blotches on the 4th to the 8th lateral rows, and separated only by a narrow interval from the corner of the dorsal blotches. Sometimes there are faint traces of small blotches between the upper lateral series. Intervals between the lateral rows of blotches yellowish or reddish brown, darker than those on the back; outer dorsal rows greenish or yellowish white. On the tail there are 15 black half rings, interrupted on the subcaudal scutellæ,

the scales on the tail larger than on the greater part of the body. In young specimens is distinctly visible a second series of still smaller blotches, below the one just mentioned, there being two of these opposite each one of the former, and placed on the 2d, 3d, and 4th exterior rows. Beneath greenish yellow, with obsolete greenish brown blotches, indistinctly visible through the epidermis, sometimes more conspicuous in young specimens.

There is a transverse black or dark bar on the forehead, crossing the posterior half of the postfrontals, involving only the anterior edge of the vertical, and the anterior corners of the superciliaries. Behind this a dark patch, with its anterior margin a little back of the middle of the vertical, and involving the adjoining margin of the superciliaries and occipitals, together with the greater portion of the occipitals; sometimes with a light spot in the middle: the light space included between the two patches appears to extend continuously backwards to the neck; above a dark vitta from the back part of the orbit to the posterior labial, itself a continuation of the frontal vitta. An elongated narrow vertebral spot behind the junction of the occipitals, and generally isolated from them, on each side of which is a similar patch widening behind.

This species is subject to great variations of color. Sometimes the sides of the dorsal blotches pass insensibly into the ground-color, so as to become transverse bands. At others they are light internally, with a narrow margin of black. Occasionally there is much black on the abdomen (in young specimens). The ground-color varies from gray to bright yellow, and sometimes even red. It may also happen that, by the confluence and extension of the darker margins, we have light bars on a dark ground, as on a specimen from the Scioto valley, Ohio, where, with the other characters similar, the color is of a dark brown above and on the sides, with transversely quadrate brownish ash-colored spots along the back, some one and a half or two scales long, 9 or 10 wide, and at intervals of about three scales. Of these spots there are 28 from head to anus, and about 9 on the tail, where they form half rings, with intervals a little larger than themselves.

Carlisle, Pa.	129+1.	53.	25.	28.	6.	S. F. Baird.
"	123+1.	49.	25.	24½.	5.	"
Clarke Co., Va.	143+1.	46.	25.	19.	2¼.	Dr. C. B. Kennerly.
"	127+1.	—	25.	11.	2	"
Anderson, S. C.	—	—	—	—	—	Miss C. Paine.

Mississippi.?	135+1. 51. 25.	10.	1½.		Dr. B. F. Shumard.
" ?					D. C. Lloyd.
Scioto Valley, Ohio.	148+1. 45. 25.	26.	4.		(on dep.) Dr. J. P. Kirtland.

2. Heterodon cognatus, B. & G.—Vertical longer than occipitals. Dorsal rows of scales 23–25; outer smooth; next scarcely carinated. Scales of the rest with keels extending to their tips. Scales broader than in preceding. Disproportion between scales of the back, before and behind, not conspicuous. Light chestnut, with 20 yellow blotches from head to anus, and 9 on the tail. Beneath yellow.

Vertical plate pentagonal, elongated. Frontals moderate, of nearly the same length. Azygos rather broad, similar in its relations to that of *H. platyrhinos.* Rostral quite fully developed. Occipitals small, less than in *H. platyrhinos.* Scales back of head distinctly carinated. Centre of eye above the middle of the 5th labial. Orbital chain of 10–11 plates. Loral rather large, triangular. Nasals moderate. Labials 8. Penultimate rather longer than high.

Scales diminishing in width towards the back, although not becoming as linear as in *H. platyrhinos.* Scales on the hinder part of back scarcely wider than those in front.

Color above light chestnut, with transverse, sometimes more or less oblique, dorsal bars between the 7th exterior rows. These bars are bright yellow, tinged with brown in the centre, and with a darker marginal shade of the ground-color. Of these bars there are 28, from head to tail, the 20th opposite to the anus, each about ten scales long, about nine broad, and separated by intervals of from four to six scales. The proportional difference between the two colors in the tail is much as in *H. platyrhinos.* Color beneath clear dull yellow. Exterior dorsal scales mottled brownish yellow, more or less spotted and margined with brighter yellow. On separating the skin a dark spot is seen at each end of the dorsal patches, between and around which the color is yellow. Head olivaceous yellow, with the usual markings of the genus obsolete. An elongated black patch behind the angle of the jaws on each side.

Somewhat similar to *H. platyrhinos*, but the scales anteriorly are wider, nor is there that disproportion between the scales on the back before and behind. The occipitals are shorter. From *H. atmodes*, the narrower intervals between the caudal light band, the scales cari-

nated on the back of head as well as elsewhere to the tip, the more prominent rostral, (the line from the tip to the lower posterior angle of the last labial passes over the eyeball,) &c. will at once distinguish it.

A much mutilated, but much larger specimen from New Braunfels agrees with this, although the rostral is proportionally less; in other characters it is very similar. The intervals between the light bars, and the sides at their extremities are, however, much darker.

A small specimen from Indianola has much the same distribution of color as described in the young *H. platyrhinos*. The principal differences are seen in the larger head, stouter body, shorter occipitals, narrower dark line across the superciliaries and vertical, broader scales anteriorly, &c. The ground-color is mottled chestnut, with subquadrate brown blotches, indistinct at the outer edges, a circular dark spot opposite each light dorsal interval, like the dorsal series surrounded by a lighter areola; beneath each dark spot a pair still smaller. Below greenish white, blackish posteriorly, with narrow blotches of black in front. Distinct patch from eye to the last upper labial.

Indianola.	130+1. 58. 23.	26. 6.	Col. J. D. Graham.
"	129+1. 51. 25.	11. 2.	"
New Braunfels, Tex.	124+1. 56. 25.	27. 6.	F. Lindheimer.

3. Heterodon niger, Troost.—Vertical plate as long as the occipitals. Rostral prominent. Dorsal rows of scales 25, the exterior smooth, the 2d row obsoletely carinated, the rest with the scales distinctly carinated, the carinæ extending quite to the tip. Uniform black above, slate-color beneath.

Syn. *Vipera nigra*, Catesb. Nat. Hist. Carol. II, 1743, 44. Pl. xliv.

Scytale niger, Daud. Hist. Nat. Rept. V, 1799, 342.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 367; and Med. & Phys. Res. 1835, 130.

Coluber cacodemon, Shaw, Gen. Zool. III, 1802, 377. Pl. cii.

Coluber thraso, Harl. Med. & Phys. Res. 1835, 120.

Heterodon niger, Troost. Ann. Lyc. Nat. Hist. N. York, III, 1836, 186.—? Holbr. N. Amer. Herp. 1st ed. II, 1838, 105. Pl. xxiii; and 2d ed. III, 1842, 63. Pl. xvi.

Black Viper; Spreading Adder.

Postfrontals large, extending to the loral. Prefrontals smaller. Azygos rather large, separating the prefrontals entirely, and the postfrontals anteriorly: in a line with the rostral. Rostral

broad. Keel acutely distinct. Scales on the back of head keeled, though obsoletely in those next to the occipital plates. The line from tip of snout to lower angle of posterior labial, crosses the lower part of the eye, whose centre is a little in advance of the middle of this line. Orbital chain of 9 plates. Loral triangular, truncated above. Nasals rather large, less developed than in *H. platyrhinos.* Upper labials 8; 3d–6th in contact with suborbitals. Centre of eye above the juncture of the 4th and 5th.

Scales distinctly carinated, except the outer row, which is smooth, and the second, on which the carination is very obsolete, sometimes quite smooth. All the scales diminish gradually to the back, where they are quite linear; posteriorly, however, they are broader.

Color above and on the sides entirely dull black, beneath rather light slate-color, shading into milk-white on the chin and on the edge of the upper labials. The exterior rows of scales shade gently from the color of the back to that of the belly.

The *Heterodon niger* bears quite a close relationship in the character of the plates and scales to *H. platyrhinos,* from which the principal difference lies in the color. Although this species greatly resembles in color the black variety of *H. atmodes,* they may be readily distinguished. The rostral of *H. niger* is well developed, high, broad, and with the dorsal carina acute and well marked. The carination on the scales back of the head is delicately distinct, as also upon the other scales, the keel extending to the very tip. The scales on the back are linear and narrow, but become much broader in proportion towards the tail. The occipitals are longer, and the head in front of the eye longer in proportion to the part behind it. No bands evident, even obsoletely. The other differs in all these respects: rostral low, and the keel more rounded; scales on back shorter, and anteriorly rather broad, and the disproportion with those posteriorly much less conspicuous; carinæ not extending to the tip; faint bars seen indistinctly across the black of the back, &c.

Carlisle, Pa. ♀	140+1. 49. 25. 36. 6.	S. F. Baird.

Specimens from the South differ simply in being rather darker on the sides and beneath.

Abbeville, S. C.	145+1. — 25. 26. —	Dr. J. B. Barratt.
Kemper Co., Miss.	126+1. 53. 25. 28. 5¾.	D. C. Lloyd.

4. Heterodon atmodes, B. & G.—Vertical plate longer than occipitals, which are small, and as broad as long. Azygos in contact with the frontals. Rostral low, obtuse, and very little prominent. Eye more anterior. Dorsal rows 23 or 25. Outer row smooth, 2d and 3d very obsoletely carinated. Scales broader, smoother, and more rounded than in *H. platyrhinos.* Keel not extending to the tip. Black, with 18 transverse yellowish bands on the body, and 7 on the tail; the dark intervals much broader than the light bands, sometimes entirely black.

Vertical plate hexagonal, narrower behind, and more elongated than in *H. platyrhinos;* lower than the occipitals. Postfrontals large, extending down to the loral. The anterior frontals rather larger than in *H. platyrhinos,* separated by the azygos and rostral. Rostral small, moderately recurved, much smaller and less conspicuous than in *H. platyrhinos.* Superciliaries long, narrower than in *H. platyrhinos.* Scales on back of the head broad, flat, carination very obsolete. Imaginary line connecting tip of rostral, and posterior angle of last upper labial passes entirely below the eye, whose centre is anterior to the middle of this line. Eye large, its centre above the middle of the 4th labial. Loral nearly square, rather narrower above. Nasals small, which with the less development of the rostral brings the eye more forwards. Labials 7 above. Owing to a greater development of the suborbital series, (of 9 plates,) the labials are lower than in *H. platyrhinos.* The posterior upper angle of the 2d labial, as well as the 3d, 4th, and anterior upper angles of the 5th, are in contact with the suborbitals. The difference from *H. platyrhinos* in this respect is caused by the much greater size of the 2d or 3d labials, the first being much smaller than all the rest.

Dorsal rows of scales 23; exterior smooth, 2d and 3d very obsoletely carinated, rest of scales more so, but in all cases less distinctly than in *H. platyrhinos.* The keel on each scale does not extend to the tip, but becomes obsolete at a point from the tip of one-half to one-fifth of the length; while in *H. platyrhinos* it extends very nearly, if not entirely to the extreme tip, especially on the back. The scales also are broader and more oval. The tail is slenderer and more tapering than in *H. platyrhinos,* and is not as thick as the posterior part of the body.

Color above lustrous pitch-black, crossed by 18 transverse light yellow bands, from head to anus, and 7 on the tail; sides mottled with black and yellowish. Beneath yellowish, blotched with black.

The pattern of coloration is probably similar to that of *H. platyrhinos*, except that the outer edges of the dorsal blotches are confluent with the irregular markings of the sides, instead of being quite distinctly defined. Occasionally black blotches opposite the transverse light marks are evident. The light bands are sometimes interrupted and sometimes oblique; their extent is about the same as in *H. platyrhinos.* The black intervals between these light bars are much longer than in *H. platyrhinos*, occupying from 5 to 6 scales anteriorly, and on the tail from 6 to 7. The light bands may have been orange in life. On the side of the head is a broad distinct black stripe from the posterior part of the eye to the posterior end of the truncated last labial, and continuous with an obscured black band across the forehead, on the posterior half of the postfrontals. Lower jaw and sides of head blotched with black.

Georgia. 131+1. 56. 23. 25. 5½. Prof. C. B. Adams.

A young specimen, apparently of this species, has the head much more depressed than in individuals of *H. platyrhinos* of the same size. The general color above is lead-gray, with transverse bands of lighter gray on the back, margined by dark chestnut, which shades gradually into the gray. The other features are well preserved, except that the rostral, as usual in young specimens, is higher.

Charleston, S. C. 137+1. 54. 25. 12½. 1¾. Dr. S. B. Barker.

Another larger specimen has the lateral spots rather more distinct. The dorsal bands are pale rose-color, (in alcohol). It agrees in the shorter occipitals, smaller number of bands, less carinated scales, lower rostral, &c.

Charleston. 141+1. 49. 25. 17. 2¾. C. Girard.

A large specimen from Charleston agrees in its external anatomy, but at first sight appears entirely black above, and of an irregular slate-color beneath. On a closer examination, however, the transverse bands are obsoletely visible, especially towards the tail. Traces of the markings on the head may likewise be distinguished. Perhaps often confounded with the true *H. niger.*

Charleston, S. C. 137+1. 53. 23. 26. 4¼. Dr. S. B. Barker.

B. *Azygos plate behind the rostral separated from the frontals by small plates.*

5. Heterodon simus, Holbr.—Vertical plate as broad as long, much longer than the occipitals. Rostral broad and high. Azygos encircled by five or eight small plates. Mouth very short. Dorsal rows 25, the three or four externals smooth. Dorsal series of 35 blotches, with one to three other series on each side. Abdomen yellowish, scarcely maculated. A narrow black band across the forehead in front of the vertical, and passing through the eye across one labial to the angle of the mouth.

Syn. *Coluber simus*, Linn. Syst. Nat. ed. xii, I, 1766, 216.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1086.

Heterodon simus, Holbr. N. Amer Herp. IV, 1842, 57. Pl. xv.

Heterodon platyrhinos, Schl. Ess. Phys. Serp. Part. descr. 1837, 97. Pl. iii, figs. 20–22.

? *Vipera capite viperrens*, Catesb. Nat. Hist. Carol. II, 1743, 56. Tab. lvi.

Hog-nose Snake.

Vertical plate subheptagonal, sometimes nearly triangular; with three sides anteriorly, the lateral against the postfrontals, the middle against the azygos plates, the sides very obtusely angled. Superciliaries rather short, broad. Occipitals very short, almost as long as broad. Postfrontals moderate, the exterior angle scarcely reaching the angle of the loral; the two separated by three small plates posterior to the azygos. Anterior frontals not much smaller. Azygos plate resting anteriorly against the rostral, and touched by the inner angle of the prefrontal: there is a small plate on each side, between it and the notch at the junction of the anterior and postfrontals, while behind, the space between it, the postfrontals, and the vertical is occupied by the three small plates already mentioned. This azygos is thus surrounded on the sides and posteriorly by five small plates, (this number is sometimes greater). Rostral broad and high, much recurved. Eyes moderate, situated posterior to the centre of imaginary line connecting the last labial and rostral, which would pass nearly through its centre. Loral subtriangular, acute above, scarcely reaching to the exterior angle of the postfrontal, a small plate sometimes intervening. Nasal plates rather short and high; nostril occupying most of the posterior one, its infero-anterior wall constituted by the first labial, its lower by a small plate. Labials 7 above; increasing very rapidly from the diminutive first; 5th and 6th largest;

all much higher than broad. Lower labials 9. Curve of upper jaw very convex and short.

Scales back of the head short, curved, obsoletely carinated. Dorsal rows of scales 25, outer rows smooth, sometimes only three, the carination slight, increasing to the medial row. Scales shorter and broader than in the other type, becoming narrower on the back; those behind rather narrower than before. Body contracted at the anus, then expanding or swelling on the tail, which is thick throughout, tapering suddenly at the tip. Scales on the tail longer and broader than those of the upper part of the body in front; carination not very distinct, inferior three rows truncated behind, especially the highest.

A dorsal series of transverse black blotches, 35 from head to tip of tail, the 27th opposite the anus. These are sometimes oblique, but generally transverse, and with the anterior and posterior margins parallel: they are about 9 scales wide, and three to four long, with light brownish yellow intervals one or one and a half scales wide. On each side, and opposite the intervals, is a distinct series of subquadrate or circular black spots on the 6th–9th rows, not touching those on the back, and between them a dusky shade opposite the dorsal spots. Below these again are usually two smaller blotches to each spot. Intervals between the spots mottled yellowish brown. Beneath yellowish, with obsolete small brown blotches. On the tail there are 9 half-rings, rather wider than the light intervals, and somewhat contracted above.

A narrow black line crosses the forehead, on the posterior half of the postfrontals, and just margining the vertical; this passes through the centre of the eye, and is continued to the postlabial. A medial patch of black expanding behind, starts from the commissure of the occipitals, from which plates others, one on each side, pass across the angle of the jaws, the three confluent with the dark color in the occipitals. In *H. platyrhinos* this medial patch is isolated, and not in contact with the occipital one.

Charleston, S. C. 117+1. 35+9. 25. 18. 3½. C. Girard.

Some specimens from Abbeville, S. C., vary in having the rostral separated from the prefrontals by two or three small plates, and the azygos entirely cut off from the frontals by intervening plates. The lower wall of the rostral is constituted by two small plates: there is a second small plate above the loral; in fact a general tendency to

break up into small plates. The markings on the back are restricted to a dorsal series, with a dusky shade opposite, and a lateral series opposite the light yellowish intervals; the ground-color of the sides a quite uniform yellowish brown. Specimens from Mississippi have the dorsal spot smaller and nearly circular.

Abbeville, S. C.	130+1. 55. 27.	15½.	1¾.	Dr. J. B. Barratt.
"	119+1. 46. 25.	19.	3¼.	"
"	130+1. 32. 25.	14½.	1¾.	"
"	132+1. 30. 25.	12.	1½.	"
Mississippi.	132+1. 34. 25.	16.	2.	Dr. B. F. Shumard.
"	132+1. 39. 27.	14.	2.	"

6. Heterodon nasicus, B. & G.—Vertical broader than long. Rostral excessively broad and high. Azygos plate surrounded behind and on the sides by many small plates (12–15). A second loral. Labials short and excessively high. Dorsal rows of scales 23, exterior alone smooth. A dorsal series of about 50 blotches, with four or five others on each side. Body beneath black. A narrow white line across the middle of the superciliaries; a second behind the rostral. A broad dark patch from the eye to the angle of the mouth, crossing the last two labials.

Syn. *Heterodon nasicus*, B. & G., Reptiles in *Stansbury's* Expl. Valley of Great Salt Lake, 1852, 352.

Vertical plate very broad, subhexagonal. Occipitals short. Rostral very broad, high, more than in the other species, outline rounded. The interval between the opposite frontals, the rostral, and the vertical occupied by a number of small plates, from 10 to 12, or more, arranged without any symmetry, on each side and behind the small azygos. The base of the rostrals between the opposite anterior nasals, is generally margined by these small plates, which sometimes, too, are seen between the vertical and the anterior portion of the superciliaries. This crowding of plates causes the anterior part of the forehead to be broader than in *H. simus.* Eye small, its centre rather posterior to the middle of the imaginary line connecting the tip of rostral with the lower angle of the postlabial, which line scarcely crosses the eyeball. Orbital plates, 10–13 in number. Loral triangular, rather longer than high, separated from the frontal by a small plate. Nasals rather short, occasionally with the lower part of the nostril bounded by a small plate. Labials 8 or 9 above, all of them higher than long; indeed, their vertical extension is

much greater than in any other species: the 6th highest, centre of eye over the junction of the 5th and 6th.

Dorsal rows of scales 23, outer row smooth, rest all distinctly carinated, the keels extending to the ends of the scales; those just behind the occipital plates truncated, with obsolete carinæ. Scales on the hind part of the body rather broader and shorter than anteriorly; the inequality scarcely evident in large specimens.

Ground-color light brown, or yellowish gray, with about 50 dorsal blotches from head to tip of tail; the 39th opposite the anus. These blotches are quite small, rather longer transversely, subquadrate, or rounded, indistinctly margined with black, (obsoletely on the outside); they cover 7 to 9 scales across, are 2 to 2½ long, and separated by interspaces of 1½ scales, which are pretty constant throughout, though rather narrower on the tail. On each side of the dorsal row may be made out, under favorable circumstances, four alternating rows of blotches; the first on the contiguous edges of the scales of the first and second exterior dorsal rows; the second on the scales of the 3d row, and the adjacent edges of those in the 2d and 4th; the third on the scales of the 4th, 5th, and 6th, and the adjacent edges of the 3d and 7th; and the fourth on the scales of the 6th, 7th, and 8th rows, and the adjacent edges of those of the 5th. This last is opposite the intervals of the dorsal series; the rest alternate with it. The central inferior surface of the abdominal scutellæ is black, sharply variegated with quadrate spots of yellowish white; the portion of the scutellæ entering into the side of the body is yellowish white, with that part opposite the dorsal intervals dark brown, thus, in fact, constituting a fifth lateral series of blotches, alternating with the lowest already mentioned. The throat and chin are unspotted. The head is light brown, with a narrow whitish line finely margined before and behind with black, which crosses in front of the centre of the vertical, and through the middle of the superciliaries: a second similar but more indistinct line runs parallel to this, just behind the rostral, and extending down in front of the eye. A third equally indistinct and similar line crosses the posterior angle of the vertical, and runs back on the side of the neck, behind the labials and temporal shields. There is a broad brown patch from the back part of the eye to the angle of the mouth, across the penultimate and last labial. The coloration is thus very different from that of *H. simus*, where there is a distinct narrow black band across the forehead scarcely involving the vertical, and passing through the eye to

the angle of the mouth across the last labial. Behind this a much broader yellowish band, continued without interruption into the neck behind the angle of the mouth. In *H. nasicus* the most conspicuous feature is a narrow white band, much narrower than the darker patch before and behind it. The dark patch, to the angle of the mouth, is much broader, continuous as it were, with the broad bar between the middle and anterior light lines, which corresponds with the narrow black line of *H. simus*. The other distinguishing features are evident. The three dark patches behind the head are much as in *H. simus*.

In the larger specimens from Sonora and the Copper Mines, the ground-color is yellowish gray, each scale minutely punctate with brown. The blotches are all obsolete, only one dorsal and two lateral on each side being defined by darker shades. The blotches on the sides of the abdomen are wanting, but the black in the middle is strongly marked. The other characters, however, are preserved, except that the exterior row of dorsal scales is more or less carinated.

Rio Grande.	138+1. 45. 23.	7¾. 1¼.	Gen. S. Churchill.
Red River, Ark.	148+1. 40. 23.	12. 1½.	Capts. Marcy & McClellan.
Ft. Webster, Santa Rita del Cobre.	146+2. 34. 23.	21. 2½.	Col. J. D. Graham.
Sonora, Mex.	150+1. 39. 23.	24. 3.	"

A specimen from California has the rostral rather less developed and four irregular plates on top of head. The coloration differs in having the light transverse intervals between the dorsal blotches narrower, especially posteriorly.

California.	137+2. 48. 23.	22¼. 4.	Dr. Wm. Gambel.

GENUS **PITUOPHIS**, HOLBR.

GEN. CHAR. Body subcylindrical, deeper than wide, attaining often a considerable size. Head elongated, ovoid, in some instances narrow anteriorly. Vertical plate elongated, sometimes as broad anteriorly as long. Superciliaries large, subtriangular. Posterior frontals two pairs, an internal and external, both elongated. Prefrontals subquadrate. A small loral. Postorbitals three or four; anteorbitals generally two, occasionally only one. Temporal shields very small, resembling the scales. Cleft of mouth curved. Dorsal rows of scales 29–35, variable in some species; those on the back carinated, on the sides smooth. Abdominal scutellæ 209–243; posterior large and entire. Subcaudal scutellæ all bifid.

Ground-color whitish or reddish yellow; a triple series of dorsal black blotches, those of the medial series the largest; several series of smaller blotches on the flanks. Abdomen unicolor or maculated, with an outer row of blotches. Head of the same color as the body, maculated with black spots. A narrow band of black across the upper surface between the eyes, and a postocular vitta on each side, extending obliquely from the eye down to the angle of the mouth. A black vertical patch is often seen beneath the eye.

SYN. *Pituophis*, HOLBR. N. Amer. Herp. IV, 1842, 7.

Pityophis, HALLOW. Proc. Acad. Nat. Sc. Philad. VI, 1852, 181.

Churchillia,* BAIRD & GIRARD, Reptiles in *Stansbury's* Expl. of the valley of the Great Salt Lake, 1852, 350.

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* The species upon which the genus *Churchillia* was established, exhibits in the structure of the cephalic plates the remarkable character of having a small median plate in advance of the vertical, limited on each side by the external, and in front by the internal postfrontals. This character, together with the presence of two anteorbitals and four postorbitals, one more on either side than in *Pituophis melanoleucus*, the only species then known, appeared a sufficient generic character. Since the discovery of several other species, in which there are two anteorbitals and four postorbitals, with the structure of the cephalic plates similar to what they

1. Pituophis melanoleucus, Holbr.—Head ovoid, broad behind. Anteorbital 1; postorbitals 3. Dorsal rows of scales 29, the four outer rows smooth, 5th, 6th, and 7th with an obsolete keel. Tail about $\frac{1}{7}$ of total length. Head maculated with black; an oblique vitta from the orbit to the 7th labial. Color of the body whitish, with a dorsal series of very large blotches, the 24th opposite the anus; anteriorly and posteriorly emarginated on the anterior third of the body, oblong posteriorly. Elongated smaller blotches on the flanks, forming three indistinct series, often confluent. Abdomen unicolor. A series of 20–29 distinct blotches along the extremities of the scutellæ.

Syn. *Coluber melanoleucus*, Daud. Hist. Nat. Rept. VI, 1799, 409.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 359; and Med. & Phys. Res. 1835, 122.

Pituophis melanoleucus, Holbr. N. Amer. Herp. IV, 1842, 7. Pl. i.

Pine Snake, or Bull Snake, Bartram, Trav. in Carol., Geo., and Florida, 1791, 276.

Head robust, conical. Vertical plate subpentagonal, broad anteriorly. Occipitals a little larger than the vertical, and as broad anteriorly as long. Internal postfrontals elongated and subtriangular; external postfrontals polygonal. Prefrontals quadrilateral, separated by the rostral. Rostral narrow, very convex, raised above the surface of the snout, and reaching the internal postfrontals. Nasals very large, anterior one the larger. Nostrils vertically oblong, situated in the middle and between both plates. Loral ovoid, small, horizontal. One large anteorbital, with its anterior margin convex, of the same width above as below. Three postorbitals, proportionally large. Temporal shields small, six or nine, or more. Upper labials 8, 7th largest, 4th coming into the orbit. Lower labials 14, 5th and 6th largest, the five posterior ones quite small. Posterior pair of mental shields one-third of the size of the anterior pair, and reaching backwards to opposite the middle of the lower 6th labial. Tail conical and tapering, forming about the seventh of the total length.

The ground-color, when living, is said to be white; as preserved in alcohol it is yellowish brown. The head is maculated with small black spots; frontal bar rather wide; postocular vitta broad. A dor-

are in *P. melanoleucus*, we deem it expedient to place *Churchillia bellona* in the genus *Pituophis*. One might well have been familiar with the reptiles of North America described before 1851, and not be prepared to identify species presenting the characters just alluded to.

sal series of very large blotches, of a deep chestnut-brown, broadly margined with black anteriorly and posteriorly. These blotches are 24 in number from the head to opposite the anus, and 6 on the tail, where they extend laterally down to the subcaudal scutellæ. More or less confluent, and consequently irregular in shape on the anterior third of the body, they are posteriorly subround or subquadrate, emarginated in front and behind, and separated from each other by a light space embracing four scales, whilst the blotches themselves cover six scales. The flanks are blotched but very irregularly; on the anterior region of the body the blotches elongate in the shape of longitudinal bands or vittæ; on the middle region three indistinct series may be traced, alternating and often confluent by their corners; posteriorly there is only one series opposite to the dorsal, and often confluent with it, so that the corresponding blotches form single patches, extending from the back to the abdomen, and tapering on the sides. The abdomen is dull yellow, with a series of distant blackish brown patches along the extremity of the scutellæ, often extending to the outer row of scales.

Carolina. 216. 60. 29. 55¾. 8. (on dep.) Acad. Nat. Sc.

2. Pituophis bellona, B. & G.—Head elliptical, rather pointed. Vertical plate very broad anteriorly. A second anterior vertical, small, and subcordiform. Anteorbitals 2; postorbitals 4. Dorsal rows of scales 31–35; the seven outer rows smooth. Tail about $\frac{1}{12}$ of total length. Head maculated with black; transverse frontal bar extending from one orbit to the other, well marked; the oblique postocular vitta rather narrow, and reaching the angle of the mouth. Color of the body whitish yellow, sometimes reddish yellow, with a dorsal series of deep black blotches, or of deep brown, margined with black, 51 in number, from the head to the origin of the tail, and a series of smaller spots on each sides. Ten transverse jet-black bars on the tail. Flanks crowded with small and irregular blotches. Abdomen dull yellow, maculated with black blotches more or less crowded.

SYN. *Churchillia bellona,* B. & G. Reptiles in *Stansbury's* Expl. Valley of Great Salt Lake, 1852, 350.

Pituophis affinis, HALLOW. Proc. Acad. Nat. Sc. Philad. VI, 1852, 181.

Head broad behind, and well separated from the body by a contracted neck, very much tapering to the end of the snout, subquadrangular from the eyes forwards. Upper surface flattened, snout elevated and rounded. Occipital plates triangular, as broad anteri-

orly as long. Superciliaries longer than either the vertical or occipitals. Vertical subpentagonal very broad anteriorly, as broad as long, and very much tapering posteriorly; its sides concave. The second small subcordiform anterior vertical is situated between the external postfrontals, which are comparatively the larger. Internal postfrontals irregularly triangular, and smaller than the prefrontals, which are irregularly quadrangular. The rostral is proportionally narrow, and raised above the surface of the snout, not reaching, however, the internal postfrontals. Nasals subquadrangular, anterior one a little larger; nostrils situated between the two plates, but more in the posterior one. Loral very small, narrow, and elongated, horizontal in position. Two anteorbitals, inferior one very small; upper one very regular, slightly convex on its anterior margin. Postorbitals four in number, occasionally only three, the two upper ones a little the larger. Numerous small temporal shields. Upper labials 8, 6th and 7th somewhat larger. Lower labials 13, 7th largest; the six posterior ones the smallest. Dorsal scales elliptically elongated, constituting 31–35 rows, the seven outer of which are smooth, the others carinated, the five outermost very sensibly the larger.

The ground-color is whitish yellow: on the anterior third and upper part of the body, the bases, and sometimes the two anterior thirds of the scales are jet black, so as to make the ground-color appear black. There are 51 large chocolate-brown dorsal blotches, margined with jet black from the head to opposite the anus, and 10 on the tail. On the anterior portion of the body these blotches are subcircular, or rather elliptical, covering in width seven or eight rows of scales, and four and two half-scales in length; the spaces between embrace about two scales. Posteriorly the blotches become quadrate, and the intermediate spaces increase so as to be at first equal to the blotches, and towards the origin of the tail they are actually wider by one scale than the blotches themselves. On the tail the blotches assume the shape of narrow transverse bars, tapering downwards. On each side of the dorsal blotches is a series of much smaller and somewhat irregular blotches, margined with black, the blotches being opposite to the light spaces, alternating, but not confluent with the medial blotches. On the anterior third of the body a series of small blotches is observed on the flanks, and beneath it, a series of elongated black patches, all of which exhibit a tendency to become obsolete vertical bars, more apparent posteriorly in very large individuals, giving to the flanks a nebulous appearance. The head

above is yellowish brown, with small black spots on the vertex and occiput. Frontal black bar distinct in small individuals, obsolete in large ones; postorbital vitta narrow; suborbital spot small. Inferior surface of the head and abdomen light straw-color, with an external series of distant black spots on each side, confluent under the tail, and constituting a medial band.

Betw. San Antonio & El Paso.	228. 44. 33.	$61\frac{7}{8}$. $5\frac{3}{8}$.	Col. J. D. Graham.
Rio Grande.	231. 53. 33.	$61\frac{7}{8}$. $5\frac{3}{8}$.	Gen. S. Churchill.
F't Webster, Santa Rita del Cobre.	225. 63. 31–33.	$44\frac{1}{8}$. $6\frac{1}{4}$.	Col. J. D. Graham.
"	225. 63. 31.	39. $5\frac{1}{4}$.	"
Sonora, Mex.	222. 60. 29–31.	$23\frac{5}{8}$. $4\frac{1}{4}$.	"
California.	226. 58. 31.	$45\frac{7}{8}$. $5\frac{7}{8}$.	Dr. W. Gambel.

3. Pituophis McClellanii, B. & G.—Head subelliptical. Rostral plate very narrow. Anteorbitals 2; postorbitals 4. Dorsal 33–35 rows; the 7 outer rows smooth. Tail forming $\frac{1}{9}$ or $\frac{1}{10}$ of total length. Postocular vitta brown, and rather broad. Suborbital black patch conspicuous; commissure of labials black. Color of body reddish yellow, with a series of 53 blotches from head to origin of tail. Blotches of adjoining series, on either side, confluent across the light spaces between medial blotches. Flanks covered with small blotches, forming 3 or 4 indistinct series. Twelve transverse jet black bars across the tail. Abdomen yellowish, thickly maculated with black patches.

Head proportionally large, ovoid, detached from the body. Snout pointed. Occipital plates small. Vertical broad, subpentagonal, slightly concave on the sides. Superciliaries large. Internal postfrontals rather narrow, elongated, external postfrontals quadrilateral, a little broader forwards. Prefrontals irregularly quadrangular. Rostral very narrow, extending halfway between the prefrontals, convex and raised above the surface of the snout. Nostrils in the middle line between the nasals, the posterior of which is a little the smaller. Loral trapezoidal, proportionally large. Inferior anteorbital very small, resting upon the fourth upper labial. Postorbitals varying in comparative size. Temporal shields small, resembling scales. Upper labials 8, 6th and 7th the larger. Lower labials 12, 6th and 7th largest. Posterior mental shields very small, extending to opposite the junction of the 7th and 8th lower labials. Scales propor-

tionally small, in 33–35 rows, the 7 outer ones perfectly smooth and somewhat larger than the remaining rows.

Ground-color yellowish brown, with three series of dorsal black blotches, 53 in number, from the head to opposite the anus, with 12 on the tail, in the shape of transverse bars. Those of the medial series the larger, and covering 8 or 9 rows of scales. On the anterior part of the body they are subcircular, embracing longitudinally four scales; posteriorly they become shorter by one scale. The light spaces between are a little narrower than the blotches themselves for the twelve anterior blotches, and wider than the blotches for the remaining length of the body. The blotches of the adjoining series alternate with those of the medial series, being opposite to the light intermediate spaces, across which the blotches of either sides are generally united by a transversal narrow band. The flanks are densely covered with small and irregular blotches, forming three indistict series, confluent in vertical bars towards the origin of the tail. Inferior surface of the head yellowish, unicolor. Abdomen dull yellow, with crowded brownish black blotches in series on the extremity of the scutellæ.

Red River, Ark.	231. 52. 35.	$38\frac{1}{4}$. $4\frac{7}{8}$.	Capts. Marcy & McClellan.
"	231. 52. 33.	$24\frac{1}{2}$. $2\frac{7}{8}$.	"

4. Pituophis catenifer, B. & G.—Head subelliptical, flattened above. Vertical plate elongated, nearly equilateral, posterior triangular portion excepted. Rostral broad. Anteorbitals 2; postorbitals 3. Loral trapezoidal, proportionally larger than in other species. Dorsal rows of scales 31; the 4 external rows smooth. Tail forming about $\frac{1}{7}$ of the total length. Frontal black bar conspicuous. Postocular vitta of a jet black, reaching the angle of the mouth between the penultimate and last upper labials. Color of body grayish yellow, the triple series of dorsal black blotches, 61 in number, from the head to the origin of the tail, forming a continuous chain all along the back, owing to the confluence of the lateral series of small blotches with the large medial series, with which they alternate. A series of proportionally large subcircular blotches along the middle of the flanks. Middle of the abdomen unicolor, with an external series of black spots on each side.

Syn. *Coluber catenifer*, Blainv. Nouv. Ann. Mus. Hist. Nat. III, 1834. Pl. xxvi. figs. 2, 2 a, 2 b.

Head subelliptical. Vertical plate maintaining its width posteriorly. Superciliaries proportionally large. Occipitals very much

dilated anteriorly, tapering posteriorly. Prefrontals proportionally small, subcircular. The nasals are nearly equal in size, and the nostrils open between their commissure near the edge of the prefrontals. Rostral proportionally broad, even with the surface of the snout. Loral small, subelliptical and oblique. Two anteorbitals, the upper one very large, the lower one small, resting on the fourth upper labial. Three postorbitals of nearly the same size. The temporal shields, ten to twelve in number, are slightly larger than the contiguous scales. Upper labials 8, 7th the larger. Lower labials 12, 5th and 6th largest. Posterior mental shields very narrow, extending beyond the 6th lower labial. Dorsal scales narrow and rather acute, constituting 31 rows, the outer one of which is considerably the larger. Tail very tapering.

Ground-color above fuscous, with a triple series of black blotches along the back, 78 in number, the 61st opposite to the anus; 17 on the tail. The blotches of the medial series are proportionally very large, quadrangular, longer than broad, covering six rows of scales, and the half of the adjoining rows, embracing longitudinally five or six scales. A narrow light space of one scale exists between each blotch. The adjoining series is composed of much smaller blotches, alternating and covering three rows of scales confluent with the middle ones, thus forming a continuous chain on the back, and enclosing entirely the light spaces between the blotches. A series of subcircular or oblong blotches runs conspicuously along the middle of the flanks, on the 4th, 5th, 6th, and 7th rows of scales. These are 88 in number, the 71st opposite to the anus, and 10 along the anterior half of the tail. The five first blotches are elongated, and exhibit a tendency towards forming a vitta or band. From the middle region of the body to the tail, two obsolete series of very small blotches are seen alternating with the series of the flanks, one above and one below. The abdomen is yellowish, unicolor, except a series of blotches on the extremities of the scutellæ, extending sometimes to the outer row of scales.

San Francisco, Cal. 230. 71. 31. 35. 5⅞. (on dep.) Expl. Exped.

5. Pituophis Wilkesii, B. & G.—Head elongated, conical forwards. Vertical plate pentagonal, much broader anteriorly than posteriorly. Rostral broad. Anteorbitals 2; postorbitals 3. Loral trapezoidal. Dorsal rows of scales 29–31; three outer rows smooth. Tail $\frac{1}{6}$ or $\frac{1}{7}$ of total length. Frontal black bar well marked. Postocular vitta extending over the last upper labial to the angle of the mouth. Color of body whitish yellow on the sides, reddish yellow above, with a dorsal series of subquadrate blotches, 70 in number, from the head to origin of the tail, and proportionally smaller than in any other species. The blotches of the two adjoining series not confluent with those of the medial one.

Head elongated, subelliptical, subpyramidal, or subconical anteriorly. Occipital plates much longer than broad, longer than either the vertical or superciliaries. Vertical pentagonal, concave laterally, tapering; length greater than the width of its anterior margin. External postfrontals sometimes divided into two plates, one of which has been called upper loral. Internal postfrontals elongated, very narrow posteriorly, sometimes also subdivided. Rostral broad, not separating the prefrontals. Nasals equal in size; nostrils intermediate and nearer to the frontals than labials. Loral not very large. Inferior anteorbitals small, and situated between the 4th and 5th upper labials. Postorbitals nearly equal in size, and generally contiguous to the anterior ones, thus excluding the labials from the orbit, into which, however, the fifth occasionally enters. Temporal shields scarcely to be distinguished from the scales. Upper labials 8 or 9, 4th or 5th occasionally coming into the orbit, penultimate the largest. Lower labials 12 or 13, 5th or 6th the largest, the six posterior ones very much reduced. Dorsal scales elliptical, forming 29–31 rows, the three outer rows perfectly smooth, slight carinæ on the 4th, 5th, and 6th rows, and not very conspicuous on the remaining ones. Tail conical and tapering.

Ground-color yellowish, with a dorsal series of subquadrate blotches, about 90 in number, 20 of which on the tail. These are deep brown, margined with black anteriorly, entirely black posteriorly; these blotches cover transversely 8 or 9 rows of scales, embracing longitudinally five to seven scales on the anterior region of the body, and two or three posteriorly. The spaces between the blotches are of the uniform width of one scale for the whole length of the body, decidedly narrower than in other species. A lateral series of blotches on each side of the medial, covering three rows of scales, and alter-

nating with the medial series. A series of blotches along the middle of the flanks opposite to the blotches of the medial series of the back. On the anterior part of the body the lateral blotches are elongated, and occasionally combine into a band or vitta behind the neck. On the anterior third of the body, an indistinct series of black spots may be seen between the scutellæ and the outer series of lateral blotches. Inferior surface of head and abdomen dull yellowish white, with two series of distant blotches, the outer series more conspicuous than the inner one, and extending to the end of the tail.

In the young the middle region of the abdomen is unicolor, and the external series of spots only exists, which, together with the series on the middle of the flanks, are most conspicuous.

Puget Sound, Or.	215. 56. 29–31.	$39\frac{5}{8}$. $5\frac{3}{8}$.	(on dep.)	Expl. Exped.
"	209. 72. 29–31.	$41\frac{5}{8}$. $7\frac{3}{8}$.		"
Oregon.	209. 66. 29.	$14\frac{1}{8}$. $1\frac{1}{4}$.		"
"	213. — 29.	$13\frac{1}{4}$. $1\frac{7}{8}$.		"

6. Pituophis annectens, B. & G.—Head elongated, elliptical. Vertical plate subpentagonal, elongated, posteriorly obtuse, with sides concave. Anteorbitals 2; postorbitals 3. Dorsal rows of scales 33, 5 outer rows smooth. Triple series of dorsal blotches confluent for nearly the whole length of the body.

Differs from *P. catenifer* in having much smaller dorsal blotches, and more interspaced. The fifteen anterior blotches of the three dorsal series almost united in a transverse or oblique band, anteriorly and posteriorly irregular. The blotches on the flanks are also proportionally smaller than in *P. catenifer*. From *P. Wilkesii*, which it resembles in the small size of the blotches, it differs by a more conical head, a narrower and longer vertical plate, and a rostral reaching higher up on the snout. The loral and superior anteorbital are quite large, and the lower anteorbital very small. In one specimen we have noticed 5 postorbitals, the 5th contiguous to the lower anteorbital, thus constituting a continuous chain beneath the eye. Dorsal scales in 33 rows, the 5 outermost perfectly smooth.

San Diego, Cal.	243. 71. 33.	$28\frac{5}{8}$. $4\frac{13}{16}$.	Dr. J. L. Leconte.

GENUS **SCOTOPHIS**, BAIRD & GIRARD.

GEN. CHAR. Form colubrine. Body cylindrical, very long—many individuals attaining a very large size, perhaps the largest of all North American serpents. Head elongated, rather narrow. Vertical plate very broad, sometimes wider than long. Posterior frontals very large. Postorbitals 2; anteorbitals one, generally very large; the longitudinal extension of this and of the postfrontals producing a much elongated muzzle. Mouth deeply cleft, outline nearly straight. Dorsal rows of scales 23–29; those along the back slightly carinated (9–15 rows), on the sides smooth. Abdominal scutellæ from 200 to 235; posterior bifid. Subcaudals all bifid.

Color brown or black, in quadrate blotches on the back and on the sides, separated by lighter intervals. Abdomen usually coarsely blotched with darker. In one species dark stripes on a light ground. Although very large and powerful, many of the species of the genus are characterized by their extreme gentleness, rarely becoming enraged, even when provoked.

1. Scotophis alleghaniensis, B. & G.—Vertical plate longer than broad. Posterior upper labial largest. Outer 7 rows of scales smooth. Dorsal rows 27. Abdominal scutellæ 235. Color black below, mottled anteriorly with white. White edges to some scales, imparting an appearance of dorsal and lateral blotches, especially in the young.

SYN. *Coluber alleghaniensis*, HOLBR. N. Amer. Herp. I, 1836, 111. Pl. xx; and 2d. ed. III, 1842, 85. Pl. xix.—DEKAY, New York Fauna. Rept. 1842, 36. Pl. xii, fig. 26.

Anterior frontals larger in proportion than in *S. Lindheimerii.* Superciliaries subtriangular. Upper labials 8, increasing behind; posterior the largest. Lower labials 11, 5th and 6th largest, decreasing posteriorly. Nostrils more in the anterior nasal. Outer seven rows of dorsal scales smooth, then an obsolete carination, increasing to the vertebral series. Each scale minutely bipunctate.

General color lustrous pitch-black; beneath, the color posteriorly is uniform slate-black; on the chin and throat dull yellowish: these

two colors, as they extend towards each other, are of less and less extent, mingling in the form of blotches: the anterior fourth shows most of yellowish, the next fourth most of the black, the posterior half uniform black. On separating the scales, those at certain successive intervals on both back and sides will be found to have their bases narrowly margined with white, as if the fundamental color consisted of dark blotches on a white ground, as in *S. Lindheimerii.*

A second specimen, smaller, shows the same characters, but with more of white beneath.

Carlisle, Pa.	234+1. 86. 27.	59½. 10¾.	S. F. Baird.
Unknown.	233+1. 83. 27.	39¾. 7⅞.	Unknown.

2. Scotophis Lindheimerii, B. & G.—Head broader than in *S. alleghaniensis*. Vertical plate as broad anteriorly as long. Posterior upper labials smaller than in *S. alleghaniensis.* Dorsal series 29; abdominal scutellæ 228–235. Black dorsal and lateral blotches; intermediate space rather lighter, with scales edged with white. Scale on sides of neck white, each with bluish spot.

Occipitals moderate, their commissure equal in length to the vertical. Orbits moderate, above the 4th and 5th labials, centre about midway between the snout and angle of the mouth. Anterior orbital large, single, extending nearly to the outer angle of the vertical. Loral trapezoidal, highest anteriorly. Nasals moderate, including nostrils between them. Labials 8 above, moderate, posterior small; 12 below; posterior very small, 6th and 7th largest. Nine rows of scales between labials and abdominal scutellæ at the angle of the mouth. Outer ten rows smooth, then carinated very obsoletely, rather more decidedly and in increasing degree towards the back.

Color above dark lead color, constituted by a dorsal series of quadrangular blotches, about 34 from head to anus, rather acutely emarginate before and behind, occupying a width equal to about 15 scales. The lozenge-shaped intervals between these blotches are from two to three scales long centrally, diminishing and becoming more linear posteriorly. On each side, and alternating with the dorsal series, is a second alternating one, composed of subrectangular elongated blotches, and alternating again with these is a second indistinct series along the edge of the abdomen. The entire system of coloration is very difficult to define, the general appearance being that of a black snake with irregular obsolete mottlings of white.

The intervals between the blotches may be indicated as being white, with the centre and apex of each scale lead color, the proportion of the latter being very small on the sides, and increasing to the dorsal line. The scales in the centres of the blotches have the basal half narrowly margined with white, as is the case, to some extent, with the lateral spots. Beneath greenish white, with the centres of the scutellæ mottled with dark slate-blue, increasing backwards. Chin and throat immaculate yellowish white, scales on the sides with a bluish spot on the apex.

The colors described are those as preserved in alcohol. Probably the color of the animal when alive is much like that of *Bascanion constrictor* or *Scotophis alleghaniensis*.

In the general obsoleteness of the markings, the blotches may sometimes be detected as more or less confluent between the different series.

New Braunfels, Tex. 227+1. 81. 29. 36. 7. Dr. F. Lindheimer.

A second specimen much larger, of what appears to be the same species, differs in having the belly nearly uniform yellowish : the black of the upper parts is replaced by umber-brown. The blotches are visible, but very obsoletely.

Indianola. 234+1. 85. 29. 60. 9. Col. J. D. Graham.

3. Scotophis vulpinus, B. & G.—Head rather short, vertical broader than long. Postfrontals very large, as long as the verticals, penultimate upper labial largest. Dorsal series 25; outer 4 rows smooth. Abdominal scutellæ 203. Subquadrate dorsal blotches transverse, 3 or 4 scales long. Tail tumid.

Anterior frontals much smaller than the posterior. Rostral broad. Occipitals broad, rather short, longer than the vertical. Eyes smaller than in *S. alleghaniensis*, centre over the junction of the 4th and 5th labials. Upper labials 8, penultimate one the largest, last somewhat smaller: lower 10, 6th the largest. Anteriorly the first three or four rows are smooth, there they are very obsoletely carinated, increasing towards the back, although everywhere moderately so. Tail thick.

General aspect that of *Ophibolus eximius*, from which it is however distinguishable by the carinated scales and other generic features. Ground-color above light brown. A series of broad transverse quadrate chocolate blotches extending from head to tail, about 60 in number, 44 to anus. The first spot anteriorly is divided into two on the

nape, and occasionally the blotches anteriorly are irregular, oblique, and varying in size. This occurs, however, only on the anterior fifth of the body, behind which the intervals between the blotches are rectilinear, nearly equal, and about one and a half scales in length. The blotches are generally embraced between the 5th or 6th rows on each side, and are 3 to 4 scales long. The sides of the blotches are not linear but obtuse angled. On each side is a series of smaller rounded blotches on the 3–7th rows, similar in color to those on the back, and like them with a black border, sometimes more or less interrupted. Another series of subquadrate black blotches, about the same size as the last, is visible on the edge of the abdomen, sometimes involving the 1st and 2d rows of scales, these are opposite to the dorsal blotches. Rest of the abdomen yellowish white, with alternating quadrate blotches of black. The brown color becomes lighter on the sides.

Racine, Wisc. 202+1. 68. 25. 32. 7. Dr. P. R. Hoy.

A second much larger specimen from Michigan has the ground-color a yellowish brown, and there is a black streak from the eye to the angle of the mouth; a second vertical stripe under the eye. The spots on the back are only about 45, of which 13 belong to the tail.

This species is probably allied to *C. calligaster* of Say, but no mention is made of the abdominal blotches, and Drs. Holbrook and Hallowell assure us particularly that the scales are smooth.

Grosse Ile, Mich. 202+1. 69. 25. 57. 9. Rev. Chas. Fox.

4. Scotophis confinis, B. & G.—Vertical plate longer than broad. Nostrils more anterior than in *S. vulpinus*. Dorsal rows 25, outer rather larger; exterior 6 rows smooth; abdominal scales 240. Quadrate dorsal blotches elongated throughout, 5–6 scales long.

Head large, broad. Posterior frontals large; anterior considerably smaller; occipitals broad, large. Eye rather large; centre over the line joining the 4th and 5th labials: orbits above the whole of the 4th and 5th labials. Upper labials 8, penultimate the largest, last one large; inferior 12 or 11, posterior small. Nostrils nearly terminal. Rostral narrow, high.

Scales rather short. Outer six rows smooth, remainder very obsoletely carinated. Exterior row rather larger, rest nearly uniform.

General aspect that of *Ophibolus eximius,* from which its larger eyes and head, carinated scales, &c. at once distinguish it. Ground-color ash-gray. A series of 44 dorsal blotches, of which 12 are on the tail. These blotches are dark chocolate-brown, with obsolete black margins. They are included between the 6th and 7th row on each side, and about six scales long. They are very regular in shape, longitudinally quadrate, rather wider transversely in the middle, and with the corners slightly produced longitudinally. The gray intervals are thus not quite rectilinear, rather elliptical, but of the same width throughout. On the 2d, 3d, 4th, and 5th lateral rows is a second series of similar blotches, more or less elongated, especially anteriorly. On the side of the neck, indeed, the blotches are confluent into very narrow distinct stripes. A third series of square blotches on the side of the abdomen, involving the 1st and 2d lateral rows. Rest of belly yellowish white, with black blotches; anterior eighth immaculate. A black stripe from the posterior part of the orbit to the angle of the mouth, which it reaches on the anterior extremity of the last labial. A vertical line beneath the eye, and the edges of the labials in front also black. Some blotching on the top of the head, which is too indistinct to define.

Compared with *S. vulpinus* the eyes are larger, the vertical plate longer, the nostrils more anterior, the carination more obsolete. Body more elongated. Abdominal scutellæ more numerous. Spots longitudinal, not transverse. Scales shorter, broader, more obtusely angular.

This species is closely allied to *S. guttatus,* but is quite distinct. Its full characters can only be seen in larger specimens, which may have been confounded with *S. guttatus.* Very probably some of the numerous synonyms assigned to the latter species may belong here, but in the want of accurate descriptions, the only course left is to give a new name.

Anderson, S. C. 239+1. 81. 25. 16½. 4¾. Miss C. Paine.

5. Scotophis laetus, B. & G.—Similar to *S. confinis,* but posterior frontals larger. Vertical plate longer than broad. Dorsal rows 29. Abdominal scutellæ 227. Blotches fewer.

This species bears a close resemblance to *S. confinis,* and its characters may be best given by comparison with the latter. It differs therefore in the greater number of dorsal rows, 29 instead of 25.

The whole body and head are much stouter. Exterior eight rows smooth, rest slightly carinated. The vertical is broad before, rather acute behind. A probably monstrous feature is seen in the union of the two postfrontals, except for a short distance before, and in the loral and postnasal coalescing into one trapezoidal plate. Blotches less numerous. A broad vitta across the back part of the postfrontals, passing backwards and downwards through the eye, and terminating acutely on the posterior upper labial. A blotch across the back part of the vertical, and extending through the occipitals on each side to the nape. The spots are larger, longitudinal throughout, with occasional exceptions.

Its affinities to *S. vulpinus* are close. The vertical, however, is narrow, the eyes much larger, dorsal rows 29 instead of 25. The blotches on the back are longitudinal, and fewer in number. For the full description of this species also, it will be necessary to procure larger specimens.

Red River, Ark. 227. 77. 29. 18. 3¼. Capts. Marcy & M'Clellan.

6. Scotophis guttatus, B. & G.—Head narrow. Dorsal rows 27, outer one scarcely larger; abdominal scutellæ 215–235. A series of quadrate brick-red blotches, intervals lighter. Two light frontlets on the head, margined with black, enclosing a dark red stripe which passes through the eye, across the mouth to the neck.

SYN. *Coluber guttatus*, LINN. Syst. Nat. I, 1766, 385.—GM. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1110.—HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 363; and Med. & Phys. Res. 1835, 126.—SCHL. Ess. Phys. Serp. Part. descr. 1837, 168.—HOLBR. N. Amer. Herp. II, 1838, 109. Pl. xxiv; and 2d ed. III, 1842, 65. Pl. xiv.

Head elongated, outline nearly straight, and transversely tapering from the sides of the occiput to the subtruncate snout. Vertical large, longer than wide, pentagonal, with the lateral margins at a very slight angle with each other. Occipitals rather narrow. Eye moderate; centre rather in advance of junction of 4th and 5th labials; orbit above the whole of these labials. Labials 8 above, penultimate the largest; 11 below.

Body elongated, decidedly compressed to the tip of the tail. Dorsal rows 27. Carination very obsolete, visible only on the 13 central rows, and there very indistinctly; not evident on the tail. Scales

rather large, triangular, pointed. The exterior row little if any larger than the rest.

General color of body above light red, paler on the sides. Along the back a series of dorsal blotches, about 45 in number, 32 from head to anus. These blotches anteriorly are longitudinally quadrate, gradually becoming transverse; in front they are concave before and behind, and with the corners produced longitudinally, exteriorly they are zigzag convex. The color of each blotch is a dark brick-red, with a deep black margin half a scale wide. Exterior to the black is a lighter shade of the ground-color. On each side of the dorsal series is a second alternating one of smaller elongated blotches, similarly constituted as to color. A third opposite to the dorsal, occurs on the edge of the abdomen, and on the 1st to the 4th row of scales: in this the red is lighter, and the black is confined to a few scattered scales. The lateral blotches are more or less indistinct in places, and frequently confluent with each other and the dorsal series. Posteriorly too they are reduced more or less to the black marks in single scales. Color beneath yellowish white, with subquadrangular blotches of black, generally occupying half of the inferior surface of the abdominal scutellæ.

The ground-color of the sides extends up on the forehead in the form of a frontlet, which crosses the vertical at its anterior extremity, passes backwards along the top of the head, including the superciliaries and outside of occipitals, crosses above the angle of the mouth, and runs into the sides of the neck. This is narrowly margined on both edges with black. A second frontlet across the front of the postfrontals, narrower but similar, and bending down on each side to the anteorbital. A similarly colored blotch on the commissure of the occipitals, widening behind and constituting a centre to the dark red space enclosed by the large frontlet on the back of the neck: behind the one just mentioned is another rather larger, and the two are sometimes confluent. A dark red stripe is included between the two frontlets just described, crossing the posterior part of the postfrontals, the upper end of the anterior frontals, and through the eye, across the angle of the mouth down the sides of the neck. Vertical edges of the upper and lower labials black.

Charleston, S. C. 214+1. 79. 27. 29½. 4½. Dr. Barker.

Specimens from Kemper Co., Miss., much larger in size, agree exactly in the pattern of coloration. The red is, however, more or

less effaced, probably by the alcohol. The blotches are light hazel, and the interspaces light chocolate.

Smaller specimens from Georgia differ only in having the blotches dark hazel, lighter centrally. The intervals are ash-gray.

The young sustain a close resemblance to the species described from Anderson, S. C. The scales are scarcely if at all carinated however; the dorsal rows two more: the blotches less regularly quadrate and not elongate posteriorly. The shape of the head and its plates are different. The markings on the head in the latter are reduced to a uniform black band across the postfrontals, passing back through the eye, and ending acutely on the angle of the mouth. The scales also are more carinated.

Kemper Co., Miss.	226+1. 69. 27.	43.	7.		D. C. Lloyd.
"	223+1. 66. 27.	47.	7.		"
Mississippi.	— — 27	—	—		Dr. B. F. Shumard.
Savannah, Ga.	226+1. 65. 27.	21.	$3\frac{1}{4}$		R. R. Cuyler.
Georgia.	236+1. — 27.	12.	$1\frac{7}{8}$.	(on dep.)	Prof. Adams.
"	228+1. — 27.	$13\frac{5}{8}$.	2.		"

7. Scotophis quadrivittatus, B. & G.—Shape of head resembling most that of *S. lætus.* Vertical broader anteriorly and more tapering posteriorly. Dorsal rows of scales 27, the five or eight medial rows alone carinated; the carination obsolete. Greenish yellow, with four longitudinal brown bands.

SYN. *Coluber quadrivittatus*, HOLBR. N. Amer. Herp. III, 1842, 89. Pl. xx.
Chicken Snake, BARTR. Trav. in Carol., Geo. & Florida, 1791, 275.

Body slender, tail very slender, about the fifth of the total length. Head elliptical, quite detached from the body by a slender neck. Eyes large. Vertical plate pentagonal, slightly concave on the sides, equalling in length the commissure of the occipitals. The lower portion of the anterior orbital is narrower than in *S. lætus.* Loral trapezoidal. Two elongated and small temporal shields. Upper labials 8, 7th largest; lower labials 10, 5th largest. Rostral hexagonal. Scales very thin, lozenge-shaped, constituting 27 dorsal rows. Slight traces of carination may be observed on the five or eight medial rows. The outer row is composed of scales as high as long; in the second row they are perceptibly larger than the remaining ones.

Ground-color above greenish yellow, with four longitudinal brown bands, covering each one entire row of scales and the half of the ad-

joining rows. The lateral bands thus extend along the 3d, 4th, and 5th rows, the 4th being the one entirely covered. The dorsal bands extend along the 10th, 11th, and 12th rows, the 11th being entirely covered. The space between the dorsal and lateral band embraces four entire rows of scales, and the half of the adjoining ones. The dorsal space between the dorsal bands comprises three entire rows of scales and the half of the adjoining rows. The abdomen, head and tail beneath are uniformly light straw-color. On the removal of the epidermis the dark bands disappear to a considerable extent, and then indistinct and obsolete quadrate spots become visible on the sides, and probably on the back. The edges of many of the scales are lighter.

Florida. 236+1. 93. 27. 23½. 5¾. (on dep.) Prof. Agassiz.

Genus **OPHIBOLUS**, Baird & Girard.

Gen. Char. Body rather thick, tail short. Dorsal rows 21, (in one group 23,) the scales hexagonal, arranged in longitudinal series, broad, short, scarcely overlapping, nearly as high as long, all perfectly smooth and lustrous. Abdominal scutellæ 180–220; posterior entire Subcaudal all bifid. Head short, depressed, but little wider than the body. Eyes very small. Vertical plate very broad. Postorbitals two, the lower in notch between the 4th and 5th labials. One anteorbital, like the loral, small. Nasals two, with the nostril between them. Upper labials 7.

Ground-color black, brown, or red, crossed by lighter intervals generally bordered by black.

The type of the genus is to be found in *O. Sayi*, to which we would refer for more full generic characters. The red species belong to the genus *Erythrolamprus* of Boie, as understood by Duméril & Bibron.

B. *Dorsal rows* 23.

1. Ophibolus Boylii, B. & G.—Black, with upwards of 30 broad ivory white transverse bands widening on the sides. Dorsal rows of scales 23.

Vertical plate distinctly pentagonal, longer than broad: more elongated than in *O. Sayi.* Sides nearly parallel, a little shorter than the occipital plates. The sides of the head as in *O. Sayi.* Dorsal rows 23, the scales rather more elongated than in *O. Sayi.* Outer row a little larger, all the rest nearly equal. Back and sides black, crossed by about 37 ivory-white bands, the 30th opposite the anus. On the vertebral region these bands are about one and a half scales wide, with the margins parallel to about the 7th outer row of scales, where they begin to widen, so as to embrace from five to seven scales on the outer row. They continue of this width to the middle of the abdomen, where they are either confluent with the white of the opposite side, or are opposite to the black interval on the other side. The black interval between the cross bands is some eight to ten scales

long, narrowing on the sides as the white spaces enlarge, until on the outer dorsal rows it occupies them to four scales, and is continued to the middle of the abdomen; owing to a slight obliquity of the dark patches on the back, their abdominal extensions are very apt to alternate with each other on the middle of the abdomen, instead of being directly opposite and confluent. Every transition from the one condition to the other is observable. The general pattern is thus: a black body, encircled by white rings, which are wider on the sides and beneath. The end of the tail is distinctly annulated. Occasionally some of the black scales on the sides have indistinct white spots in the centres. Labials, plates on the sides of the head, and above in front of the vertical, yellow, with black margins.

El Dorado Co., Cal. 240. 52. 23. 28. 3¼. Dr. C. C. Boyle.

2. Ophibolus splendidus, B. & G.—Black above; the sides black, with a white spot in each scale. The body crossed by broad bands, consisting of white spots, one in each scale. Dorsal rows 23.

Similar in general features to *O. Boylii*. Vertical plate similar to that of *O. Boylii* but broader, and the sides more nearly parallel.

This species forms a connecting link, as to color, between the blotched varieties of *O. Sayi* and *O. getulus*. There is a series of dorsal black blotches from head to tail; in one specimen 63, the 49th opposite the anus; in the other 52, the 41st opposite the anus. These are four or five scales long, and six or seven wide. The lighter intervals between are constituted by one or two transverse rows of spots, each one on a separate scale. The scales on the sides (from the 1st to the 7th or 8th rows) are black, each one with an elongated white blotch in the centre. These blotches occupy nearly the whole scale on the exterior row, but diminish in amount towards the back. A series of rhomboidal darker spots is seen on each side opposite the light intervals, produced by the less amount of white on the scales at that place, and sometimes extend to the abdomen. The abdomen is white, blotched not very deeply with black two or three scales wide, and a continuation of the dark shade in the prolongation of the lateral rhomboids. The blotches of the opposite sides are sometimes confluent and sometimes alternate. In one specimen the black patches are rather wider, extending nearly to the abdomen. Head less blotched with yellow than *O. Boylii*. Differs

from *O. Boylii* in having the light intervals in the form of spots in the centres of dark scales, instead of covering the whole space. The lateral blotches are alternate with those of the back, not continuous and opposite. The blotches are more numerous.

Sonora, Mex.	219. 65. 23.	36. 5½.	Col. J. D. Graham.
"	215. 55. 23.	26. 4.	"

B. *Dorsal rows* 21.

3. Ophibolus Sayi, B. & G.—Black, each scale above with a large circular or yellow spot in the centre. Sometimes only transverse lines of these spots across the back.

SYN. *Herpetodryas getulus*, SCHL. Ess. Phys. Serp. Part. descr. II, 1837, 198.
Coronella Sayi, HOLBR. (non Schl.) N. Amer. Herp. III, 1842, 99. Pl. xxii.
Coluber Sayi, DEKAY, New York Fauna, Rept. 1842, 41.
King Snake.

As already remarked, we consider this as the true type of the genus, and shall accordingly reproduce some of the generic features in more detail.

Body, as in most of the other species, very tense and rigid, with difficulty capable of being extended after immersion in alcohol. Vertical plate triangular, wider than long; outer edge slightly convex, an angle being faintly indicated at the junction of the superciliaries and occipitals; shorter than the occipitals, which are short, longer than broad. Postfrontals large, broad; anterior smaller. Rostral small, not projecting, slightly wedged between prefrontals. Eye very small, orbit about as high as the labial below it; centre of the eye a little anterior to the middle of the commissure, over the junction of the 3d and 4th labials. One anteorbital, vertically quadrate; loral half its height, square. Upper labials 7, increasing to the penultimate. Lower labials 9; 4th and 5th largest.

Scales nearly as high as long, hexagonal, truncated at each end. Dorsal rows 21, exterior rather larger, and diminishing almost imperceptibly to the back, although all the scales in a single oblique row are of very nearly the same shape and size.

The scales on the back and sides are lustrous black, each one with a central elliptical or subcircular spot of ivory-white, which on the sides occupy nearly the whole of the scale, but are smaller towards the back, where they involve one-half to one-third of the length. Beneath yellowish white, with broad distinct blotches of black, more

numerous posteriorly. Skin between the scales brown. The plates on the top and sides of the head have each a yellowish blotch; the labials are yellow, with black at their junction.

Prairie Mer Rouge, La. 216. 52. 21. 42. 5. Jas. Fairie.

Other specimens agree except in having bright yellow instead of white as described; the spots too are rather smaller, and manifest a slight tendency to aggregation on adjacent scales, so as to form transverse bands. This is seen more decidedly where the back is crossed by about 70 short dotted yellow lines; the 56th opposite the anus. The scales between have very obsolete spots of lighter, scarcely discernible. The sides are yellow, with black spots corresponding to the dorsal lines; indeed, there may be indistinctly discerned two or three lateral series of alternating blotches.

Kemper Co., Miss.	211. 52. 21.	47½. 6¼.	D. C. Lloyd.
"	— — —	9½. —	"

In larger specimens from the West, this tendency in the spots to aggregation is still more distinct. The back is crossed by these dotted lines of the number and relation indicated, at intervals of four or five scales; the spots on the intervening space being obsolete. These lines bifurcate at about the 9th outer row, the branches connecting with those contiguous, so as to form hexagons, and these extending towards the abdomen again, decussate on about the third outer row, thus enclosing two series of square dark spots on each side. These lateral markings are, however, not very discernible, owing to the confusion produced by the greater number of yellow spots. On the edge of the abdomen are dark blotches, one opposite each dorsal dark space, the centres of the scutellæ being likewise blotched, but so as rather to alternate with those just mentioned.

Specimens from Indianola exhibit all varieties of coloration.

Red River, Ark.	224. 49. 21.	33¼. 3¾.	Capts. Marcy & McClellan.
Indianola.	213. 50. 21.	39½. 4¾.	Col. J. D. Graham.

4. **Ophibolus getulus**, B. & G.—Black, crossed by about 30 narrow continuous yellow lines, which bifurcate on the flanks, the very obtuse angles embracing on each side a series of very much elongated patches, and in fact, by the union of the branches with each other, dividing the back into a succession of large black hexagons.

Syn. *Coluber getulus*, Linn. Syst. Nat. I, 1766, 382.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1106.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 358; and Med. & Phys. Res. 1835, 122.—Peale, Cont. Macl. Lyc. I, 1829. Pl. v.

Pseudoelaps getulus, Fitz. N. Class. Rept. 1826, 56.

Coronella getula, Holbr. N. Amer. Herp. III. 1842, 95. Pl. xxi.

Anguis annulatus, Catesb. Nat. Hist. Carol. II, 1743, 52. Tab. lii.

Thunder Snake; King Snake; Chain Snake.

Very similar in general relations to *O. Sayi*, although the body appears rather stouter, and the head and eyes somewhat larger in proportion. The color above is deep lustrous black, crossed by about 33 continuous yellow lines, the 26th opposite the anus. These lines, which on the middle of the back are narrow, one-half or one scale in width, widen rapidly till they meet the lateral series of black blotches, when they extend longitudinally in either direction, and anastomose with their fellows. On each side, and alternating with the dark enclosures on the back, is a series of deep black blotches, extending from the abdomen (where those of opposite sides are generally confluent) over the 1st and 2d outer rows of scales. These blotches are rounded above, five or six scales long, and separated from the nearest dark part of the back by one or one-half scale. The outer edge of the abdomen, and the exterior dorsal rows between these blotches being yellow, causes the chain pattern to be continuous, enclosing a series of elongated dorsal spots, from 7 to 10 scales long and about 17 wide. Centre of abdomen largely blotched with black, usually confluent with the blotches already mentioned. The plates on the head are black, with yellow spots.

The pattern as here described is subject to some irregularities, the chain being sometimes broken, and the lines oblique, not transverse, and the dark blotches of opposite sides not truly opposite to each other.

Anderson, S. C.	224. 48. 21.	30½. 4½.	Miss C. Paine.
Charleston, S. C.	213. 52. 21.	47¼. 7¼.	Dr. S. B. Barker.
Mississippi.	— — —	— —	Dr. B. F. Shumard

5. Ophibolus rhombomaculatus, B. & G.—Light chestnut, with a dorsal series, and two lateral on each side of darker rhomboid blotches. Each blotch with still darker margins.

Syn. *Coronella rhombomaculata*, Holbr. N. Amer. Herp. III, 1842, 103. Pl. xxiii.

Above light chestnut-brown, darker along the back, lighter towards the abdomen. Each scale minutely mottled with darker. Beneath reddish yellow, obscurely blotched with light-brown. A series of 52 dorsal blotches from head to tip of tail, the 42d opposite the anus. These are irregularly and transversely rhomboidal, six or seven scales wide, one and a half to two and a half long, and separated by intervals of about 3 scales, thus wider than the blotches. Their color is darker chestnut, with still darker margins, and sometimes with a faint areola lighter than the ground-color. On each side and alternating with this series, is a second on the 2d to the 6th outer rows, and about a scale long; then a third again alternating on the 1st, 2d, and 3d rows, sometimes involving the edges of the scutellæ. These, though smaller than the dorsal spots, are similar. They are sometimes confluent with each other, though rarely with those of the back. There is a dark stripe from the eye to the angle of the mouth.

Anderson, S. C.	203. 48. 21.	24.	$3\frac{5}{8}$.	Miss C. Paine.
Georgia.	200. 44. 21.	$28\frac{3}{8}$.	$3\frac{7}{8}$.	Prof. C. B. Adams.

6. Ophibolus eximius, B. & G.—Grayish ash, with one dorsal series of upwards of 50 transversely elliptical chocolate blotches, with two other alternating lateral series on each side.

SYN. *Coluber eximius*, DEKAY, (Mss.) and N. York Fauna, Rept. 1842, 38. Pl. xii, fig. 25.—HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 360; and Med. & Phys. Res. 1835, 123.—STORER, Rep. Rept. Mass. 1839, 227.

Pseudoelaps Y, BERTH. Abh. K. Ges. Wiss. Gött. I, 1843, 67. Pl. i, fig. 11 & 12.

House Snake, Milk Snake, Chicken Snake, Thunder and Lightning Snake.

Muzzle rather broader, and the head more depressed than in the first described species of the genus: in other respects generally similar, like them having all the scales hexagonal, those on the back scarcely narrower than those on the sides, although rather more elongated than usual. Vertical longer than broad, shorter than the occipitals. General color above yellowish gray, with a dorsal series of large blotches, 55 in number from the head to the tip of the tail, the 45th opposite to the anus. These are transversely elliptical, about four scales long, covering 12 to 15 scales across the back, (more anteriorly than posteriorly,) and separated by intervals of one and a half to two scales, all of nearly the same width. The spots themselves are grayish brown or chocolate, with a broad black border, and

finely mottled internally (as is the ground-color on the sides) with black. The blotches become narrower posteriorly; on the tail their confluence with the lateral series forms black half-rings. On each side, and involving the 2d to the 5th rows, is another series of much smaller and nearly circular blotches, black with the centres brown. These alternate with the dorsal spots. Alternating with the series just described is still another similar to it, but entirely black, on the margin of the abdomen, and on the contiguous spots of the 1st, 2d, and 3d rows. These two lateral series are sometimes confluent. The anterior dorsal blotch is elongated, so as to cover the posterior half of the vertical plate: and in it is a central elongated spot of the ground-color behind the occipitals. A double light spot is seen on the junction of the occipitals, as in *Eutainia*. There are indications of a dark band across the posterior half of the postfrontals, and another from the eye to the angle of the mouth. The labials are edged with black.

The abdomen is yellowish white, with square black blotches, alternating with those already described.

The number and size of these spots varies somewhat in different specimens, though rarely less than 40 from head to anus. The young differ in having the dorsal blotches bright chestnut-red inside of the black margins. The intervals are sometimes white, or clear ash.

Westport, N. Y.	214.	54.	21.	40½.	5½.	S. F. Baird.
Somerville, N. Y.	200.	49.	21.	27.	3¼.	Dr. F. B. Hough.
Warren, Mass.	200.	55.	21.	29.	4½.	S. F. Baird.
Woburn, Mass.	—	—	—	—	—	C. Girard.
Foxburg, Pa.	—	—	—	—	—	S. F. Baird.
Carlisle, Pa.	200.	52.	21.	25.	3½.	"

7. Ophibolus clericus, B. & G.—Similar to *O. eximius*. Body stouter. Head much shorter, centre of eye above the middle of the commissure. Eye much smaller. Body light ash, crossed by less than 40 blotches, which extend to the exterior dorsal row. Only one lateral series of blotches.

SYN. *Coluber eximius*, HOLBR. N. Amer. Herp. III, 1842, 69. Pl. xv.

Similar in general appearance to *O. eximius*, but readily distinguishable by prominent characters. The head and mouth are very short,

the centre of the eye being in the centre of the commissure, not anterior to it. The vertical is as broad as long, and the occipitals are but little longer than broad. The superciliaries are very short to correspond with the minute eye. All these plates are shorter than in the corresponding size of *O. eximius.* The scales on the body are much wider in proportion, and on the sides, where they are arranged more in quincunx, owing to the less amount of truncation. Entire body much stouter than in the allied species.

The body is crossed by a series of 38 dorsal blotches, the 29th opposite the anus. They are much broader and larger than in *O. eximius*, and extend between the outer dorsal rows. These blotches are chocolate, lighter on the sides, and distinctly bordered with black; they are about five or six scales long. The intervals between the blotches are mottled ash, or pepper and salt. On each side is a second alternating series of black blotches, much smaller than the dorsal, and extending from the exterior dorsal row on the edge of the abdominal scutellæ. Beneath yellowish white, with distinct quadrate black blotches. The stripe from the eye to the angle of the mouth as in *O. eximius.*

The body, viewed from above, appears encircled by a series of black rings in pairs, enclosing a third of an ash-color. The tints as usual are darker on the back.

Clark Co., Va.	199. 49. 21.	36. 6¾.	Dr. C. B. Kennerly.
Mississippi.	— — —	— —	Dr. B. F. Shumard.

8. Ophibolus doliatus, B. & G.—Red, encircled by about 22 pairs of narrow black rings, each enclosing a yellow unspotted ring. Head red, with the first ring of the anterior pair crossing the ends of the occipitals.

Syn. *Coluber doliatus*, Linn. Syst. Nat. I, 1766, 379.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1096.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 362; and Med. & Phys. Res. 1835, 125.

Coronella coccinea, Schl. Ess. Phys. Serp. Part. descr. II, 1837, 67. Pl. ii, fig. 11.

Coronella doliata, Holbr. N. Amer. Herp. III, 1842, 105. Pl. xxiv.

Head rather more depressed than in the species of the other section. The lower postocular, which is smaller than the upper, rests in a notch between the 4th and 5th upper labials, lying longitudinally against the latter. In many other species the contact is not so intimate.

Color above yellowish white; in life, bright red. The body is encircled by 24 pairs of black rings, (the 19th opposite the anus,) each pair enclosing a yellow ring between them. Along the back the black and yellow rings are nearly of equal width, the three covering a length on the back of five or six scales. Anteriorly their intervals are 8 or 9 scales long, posteriorly somewhat less. The black rings, as they descend on the sides, separate somewhat, so as to leave an interval of about three scales; they are also somewhat narrower than above. On the abdomen they are generally interrupted, the corresponding ends of the same ring sometimes meeting, and sometimes alternating. Occasionally there are scattered black blotches on the belly between the pairs. The anterior black ring of the first pair crosses the posterior part of the occipitals, extending across between the angles of the mouth. The head in front of this is red, with a small black ring in the posterior half of the vertical. The posterior edges of the labials are black.

In a second smaller specimen from Mississippi, there are 17 pairs of rings to the anus, and 4 on the tail. The whole head is black, the first yellow interval beginning just back of the occipitals.

Not having a specimen of *O. doliatus* from the Atlantic States, we are in some uncertainty as to whether this be really the above species, especially as it differs somewhat from Dr. Holbrook's description.

Kemper Co., Miss.	208. 49. 21.	$18\frac{3}{8}$. $2\frac{5}{8}$.	D. C. Lloyd.
Mississippi.	188. 50. 21.	$8\frac{1}{2}$. $1\frac{1}{4}$.	Dr. B. F. Shumard.

9. Ophibolus gentilis, B. & G.—Muzzle more convex and acute than in *O. doliatus*. Body brownish red, encircled by about 25 pairs of broad black rings enclosing a yellow ring: the yellow mottled with black on the sides. Black rings broader than in *O. doliatus*. Upper part of head entirely black.

Ground-color dull red, encircled by 25 pairs of black rings, the 21st opposite the anus, each pair enclosing a third ring of yellowish white. The black rings are conspicuously broader above, the three crossing eight scales on the vertebral row anteriorly, and towards the anus about five. Anteriorly the intervals between successive pairs consist of about five scales, posteriorly only of two or three, thus diminishing considerably. The black rings contract as they descend, those of each pair receding slightly from each other, so as to cause the yellow portion to expand about one scale. The black rings are

continuous on the abdomen, those of contiguous pairs (not of the same pair) sometimes with their intervening spaces black. The scales in the white rings are always more or less mottled with black, especially along the sides of the body, this mottling being very rarely observable on the red portion. The anterior black ring of the first pair is extended so as to cover the whole head above, except the very tip; the yellow ring behind it involves the extreme tip of the occipitals.

A larger specimen is much duskier in its colors. The black rings extend on the back so that the contiguous rings of adjacent pairs run into each other. There are 28 pairs of rings, the 25th opposite the anus.

In a specimen from Prairie Mer Rouge, which probably belongs to this species, there are but 21 pairs of rings, the 19th opposite the anus. The rings separate more on the sides than in the other specimens, the intervals covering some six or eight scales. The black rings are mostly interrupted below; the interrupted ends of contiguous rings of adjacent pairs connected by short black blotches. The white rings are mottled, and the head is black as described.

Red River, Ark.	♀	198.	45.	21.	20.	$2\frac{3}{4}$.	Capts. Marcy & McClellan.
"		201.	—	21.	$27\frac{1}{2}$.	—	"
?Prairie Mer Rouge, La.		184.	45.	21.	$16\frac{1}{2}$.	$2\frac{1}{4}$.	Jas. Fairie

Genus GEORGIA, Baird & Girard.

Gen. Char. Vertical plate short, very broad. Superciliaries broad, and the cornea scarcely visible from above. Head rather high. Outline of the top of the head very convex. Two postorbitals; one large anteorbital. Two nasals, very short. Rostral broad, low. Dorsal rows of scales perfectly smooth, in 17 rows, overlapping or imbricated. Postabdominal scutella entire. Postfrontals much larger than the prefrontals. Size of the animal very large. Color black.

This genus has a strong resemblance to *Bascanion*, from which it differs by its stouter form, much broader vertical, one anteorbital, undivided postabdomidal scutella, &c. From *Ophibolus* it is distinguished by the broader superciliaries, deeper head, much imbricated scales, &c.

1. Georgia Couperi, B. & G.—Postorbitals resting on the 4th labial. Black above, dark slate beneath. No red marks evident on the abdomen.

Syn. *Coluber Couperi*, Holbr. N. Amer. Herp. III, 1842, 75. Pl. xvi.

Vertical plate pentagonal, as broad as long. Much shorter than the occipitals. Width of head greater than half its length. Eye rather small, its centre above the junction of the 4th and 5th labials, and anterior to the middle of the commissure. Inferior postorbital resting on the 4th labial. Loral quadrangular. Labials 7 above, increasing in size to the 4th; the 5th small, triangular, and having the 4th and 6th in contact above it; 6th very large; 7th scarcely smaller. Color intense lustrous black, the bases of the scutellæ clouded with lead-color. Plates on the inferior surface of the head with the centres brownish yellow.

Specimen described belonging to the Academy of Natural Sciences.

Altamaha, Ga. 184. 60. 17. 60. 11. Dr. J. E. Holbrook.

Genus **BASCANION**, Baird & Girard.

Gen. Char. Body slender, elongated. Tail very long. Head narrow, deep, long. Eyes very large. Postorbitals 2; anterior 2, upper very large, lower very small, in a notch between the 2d and 3d labials. Fourth labial produced up behind the eye to meet the lower postorbital. Loral one; nasals two. Vertical much elongated and narrow, concave externally. Dorsal rows of scales 17, all perfectly smooth, and subhexagonal. Abdominal scutellæ 170–200; posterior one divided: subcaudal 90–110, all bifid. Colors black or olive. Uniform above; lighter below: skin between the scales black. Young blotched.

1. Bascanion constrictor, B. & G.—Vertical diminishing for half its length, then parallel. Centre of eye over the 4th labial. In the adult, color lustrous pitch-black, above and beneath greenish black, sometimes tinged with greenish white. Chin and throat white. The young are olive, with rhomboidal dorsal blotches; beneath greenish white.

Syn. *Coluber constrictor*, Linn. Syst. Nat. I, 1766, 385.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1109.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 348; and Med. & Phys. Res. 1835, 112.—Schl. Ess. Phys. Serp. Part. descr. 1837, 133. Pl. v, figs. 3 & 4.—Storer, Rep. Rept. Mass. 1839, 225.—Holbr. N. Amer. Herp. III, 1842, 55. Pl. xi.—Thomps. Hist. of Verm. 1842, 117.—Dekay, New York Fauna, Rept. 1842, 35. Pl. x, fig. 20.

Hierophis constrictor, Bonap. Fn. Ital. II, 1841. Art. *Col. leopard.*

Vipera niger, Catesb. Nat. Hist. Carol. II, 1743, 48. Tab. xlviii.

Black Snake, Kalm, Reise N. Amer. II, 1764, 202.—Penn. Arct. Zool. Suppl. II, 1792, 92.

Vertical plate much longer than broad, pentagonal, anterior margin convex, the lateral strongly concave, the plate rapidly diminishing to half its length, thence nearly parallel, terminated by a rather obtuse angle; a little shorter than the occipitals. Superciliaries large, rather broad. Rostral rather broad and high, wedged to a slight extent between the prefrontals. Eye large, its centre before the middle of the commissure, and over the 4th labial. The lower

anteorbital very small, wedged in between the upper anteorbital, the loral, the 3d labial, and the eye. Loral trapezoidal, oblique, moderate. Labials above 7; the 1st, 3d, and 5th smaller than the rest, the 3d and 4th entering into the orbit; the 4th the only one in contact with the lower postorbital; 6th and 7th largest. Lower labials 8, the 5th much the largest. Two rows of temporal scales between the labials and occipitals. Exterior row of dorsal scales very large, diminishing gradually on the back. Scales very thin, the posterior angle moderately truncate, so as to give an elongated hexagonal shape to the exposed portion. Exposed surface of exterior row nearly as high as long.

Color above uniform lustrous pitch-black, beneath slate-color, sometimes tinged with greenish white. Lower jaw and chin, and sometimes edge of the upper labials white. Specimens from the South and South-west, as preserved in alcohol, are apt to exhibit an olive-green tinge, sometimes a dark blue, and occasionally the whole under surface has a decided greenish white color. In one or two specimens there is but one anteorbital.

Carlisle, Pa.	178+1.	93.	17.	$40\frac{1}{4}$.	$10\frac{5}{8}$.	S. F. Baird
"	189+1.	95.	17.	50.	$12\frac{1}{4}$.	"
"	184+1.	95.	17.	58.	13.	"
"	178+1.	95.	17.	$37\frac{7}{8}$.	10.	"
Anderson, S. C	179+1.	—	17.	41.	—	Miss C. Paine
"	185+1.	90.	17.	$47\frac{1}{8}$.	$12\frac{1}{4}$.	"
Kemper Co., Miss.	175+1.	—	17.	30.	$6\frac{3}{8}$.	D. C. Lloyd.
"	181+1.	—	17.	$43\frac{1}{4}$.	$11\frac{3}{8}$.	"
Mississippi.	181+1.	110.	17.	33.	10.	Col. B. C. L. Wailes.
Prairie Mer Rouge, La.	183+1.	—	17.	$28\frac{3}{8}$.	—	Jas. Fairie.

As is usually the case, the young of this species are variegated in color instead of being uniform. The ground-color is dark olive, with a succession of darker rhomboidal dorsal blotches from head to tail. These are about nine scales wide, and four or five long, separated by lighter intervals, which, narrow along the back, widen of course rapidly towards the abdomen. The edge of each scale is obsoletely lighter than the centre, the dark centres in some scales being of such intensity as to produce the impression of distinct spots, especially on the sides. Along the vertebral region, the margins of the blotches are narrowly darker, and those of the intervals lighter than on the

sides. Beneath greenish white, each scutella with from two to four dark spots on the edges. Top of head yellowish gray, posterior margins of both pairs of frontals dark chestnut, as are the contiguous edges of the superciliaries and vertical, and posterior edges of the superciliaries and occipitals as well as a small blotch on the outer edge of the superciliaries, and a broad patch in the centre of the occipitals running up into the vertical. Sides of head white, especially labials and orbitals; tinged with bluish behind the eyes, and spotted with dark brown.

Specimens over 18 inches lose the blotching, and become more and more uniform, although to a considerable size showing traces of the spots on the abdominal scutellæ.

Carlisle, Pa.	183+1. 91. 17.	21.	5¼.	S. F. Baird.
"	186+1. 83. 17.	15⅝.	3⅝.	"
"	183+1. 91. 17.	21.	5¼.	"
Anne Arundel Co., Md.	184+1. 94. 17.	14¼.	3½.	J. H. Clark.
Anderson, S. C.	180+1. 100. 17.	21¼.	5⅝.	Miss C. Paine.
"	177+1. 93. 17.	21¾.	5⅜.	"
Charleston, S. C.	177+1. 105. 17.	21⅛.	5⅜.	Dr. S. B. Barker.

2. Bascanion Fremontii, B. & G.—Black, and similar to *B. constrictor*, but stouter. Scales behind the head broader, those on the back, narrower. Tip only of the lower jaw white.

The single specimen in our possession of this species is too much mutilated to allow of an accurate diagnosis of its character. By comparison with a large number of specimens of *Bascanion constrictor*, its distinction is sufficiently evident. For the reasons given, however, it will be necessary to make the description comparative with that of *B. constrictor*. The body is stouter. The scales back of the head a good deal broader, while those on the back generally are more elongated and less truncate. The head is larger in all its dimensions. The color appears to be intense black, tinged with slate on the belly. Head entirely black, except the end of the lower jaw, which is white. The specimen was collected in California by Col. J. C. Fremont, to whom we dedicate the species.

California.	183+1. — 17.	55.	12¾.	Col. J. C. Fremont.

3. Bascanion Foxii, B. & G.—Body and head thicker than *B. constrictor*. Tail shorter. Scales broader, the two outer rows having their exposed surface higher than long. No adult procured. Immature specimen brownish olive tinged with blue: a series of transverse blotches on the back. Sides spotted.

This species is, in all probability, the young of one which when adult is entirely black, and as such confounded with the true *B. constrictor*. Its primary differences, when compared with individuals of the same size of the latter species, are to be seen in the much greater thickness of the head and body and shorter tail, this accompanied by much wider scales on the back and abdomen. The vertical plate is rather broader behind. There are two lorals, one above the other, this probably not constant. The labials are higher. The scales are all broader; the two exterior rows having their exposed parts higher than long. The posterior part of the body and tail more truly cylindrical than on the other species. Color above brownish olive, tinged with blue on the sides, each scale with a deeper shade of brown towards the tip. A series of very obsolete darker transverse blotches along the back. Beneath greenish white, with darker blotches on the sides of the abdomen. A specimen from Pittsburgh, Pa., probably belonging to this species, has three postorbitals and a single loral. It has also 19 dorsal rows, but agrees in all the other characters.

Grosse Isle, Mich.	183+2. 79. 17. 22. 5.	Rev. Chas. Fox.
Pittsburgh, Pa.	177+1. 85. 19. 15. 3½.	B. A. Fahnestock.

4. Bascanion flaviventris, B. & G.—Above dark olive-green, beneath yellow. Scattered spots of black on the sides and beneath. Head across superciliaries narrower than distance from snout to end of occipitals. Lower postorbital in contact only with the 4th labial.

Syn. *Coluber flaviventris*, Say, in *Long's* Exped. Rock. Mts. II, 1823, 185.

General characteristics of the head as in *Bascanion constrictor*, the differences being difficult to express by description. Head narrow, elongated. Greatest width on superciliaries less than half the length of plated part of head. The lower anteorbital is included between the 2d and 3d labials, the upper orbital and the eye, only touching the

loral by one corner. Lower postorbital in contact only with the 4th labial, the 5th scarcely touching it by its corner. The scales are scarcely as much elongated as in *B. constrictor*.

Above light olive-green, posteriorly tinged somewhat with reddish. Beneath bright greenish yellow, rather lighter on the tail, this color involving the lower half of the labials. The skin between the scales, but slightly extensible, is black. On the sides the scales are obscurely margined with greenish yellow, and many of them have each a single spot of black, generally near the tip. The abdominal scutellæ are also sparsely spotted in a similar manner. The spots are sometimes wanting.

A specimen from California differs in having the vertical broader.

Betw. Indianola & San Antonio.	167+1. 90. 17.	35. 10.	Col. J. D. Graham.
"	169+1. 95. 17.	29. 7½.	"
California.	188+1. 91. 17.	34. 8½.	Dr. W. Gambel.

5. Bascanion vetustus, B. & G.—Stouter than *B. flaviventris*. Breadth of head across superciliaries equal to half the interval between tip of rostral and posterior end of occipitals. Lower postorbital in notch between the 4th and 5th labials. Olive-brown above, greenish white beneath.

Head broader and shorter than in *B. flaviventris*. Vertical rather shorter, broader behind. Superciliaries and frontals much broader. Centre of eye scarcely in advance of the centre of commissure. Pro file more rounded in front. Above olive, tinged with brown; beneath greenish white, no black dots visible. There appears to be little if any black in the skin between the scales, although the basal edges of the scales themselves are slightly tinged.

San Jose, Cal.	171+2. — 17.	34. —	Dr. J. L. Le Conte
Puget's Sound.	171+1. 89. 17.	30½. 8. (on dep.)	Expl. Exped
"	164+2. 90. 17.	19. 5¼.	"
"	166+3. 79. 17.	29. 7.	"
Oregon.	165+1. — 17.	28. —	"

Genus MASTICOPHIS, Baird & Girard.

Gen. Char. Similar in general features to *Bascanion*, but still more slender and elongated. Tail very long. The head is almost as deep as broad, and the vertical plate very narrow and long. The most striking feature of difference is seen in the prolongation upwards of the 5th posterior labial instead of the 4th, to meet the lower postorbital. Superciliaries very broad and projecting, more so in proportion to the vertical than in *Bascanion*. Rostral quite small. Eyes very large. Postorbitals 2; lower resting on the upward extension of the 5th labial, not touched by the 6th. Anteorbitals 2; upper very large, lower very small, in a notch between the 3d and 4th labials. One loral and two nasals, with the nostril intermediate. Scales all very smooth. Dorsal rows 17 or 15. Abdominal scutellæ 200–210; posterior divided. Subcaudal 95–150, all divided. Abdomen blotched, seldom unicolor. Marking anteriorly and posteriorly apt to be different. The true type of this genus is to be seen in *M. ornatus*, B. & G.

A. *Dorsal rows* 17. *Tail* ¼ *length of body.*

1. Masticophis flagelliformis, B. & G.—Color black anteriorly, lighter posteriorly. Scales, when lighter, with darker margins.

Syn. *Anguis flagelliformis*, Catesb. Nat. Hist. Carol. II, 1743: 54. Tab. liv.
Coluber flagellum, Shaw. Gen. Zol. III, 1802. 475.
Coluber flagelliformis, Holbr. N. Amer. Herp. I, 1836, 107. Pl. xix.
Psammophis flagelliformis, Holbr. N. Amer. Herp. 2d ed. III, 1842, 11. Pl. ii.
Coach-whip Snake, Bartr. Trav. in Carol., Georgia, and Florida, 1791, 219.

Vertical plate wide in front, rapidly tapering, until at the anterior third it is less than half as wide as in front, thence the sides are parallel, acutely pointed behind. Superciliaries very broad, projecting. Occipitals as long as the vertical. Postfrontals large, anterior smaller. Eye large, its centre considerably in advance of

the middle of the commissure, and over the junction of the 4th and 5th labials. Upper orbital very large, extending far forwards above, its upper angle reaching the angle of the vertical. Loral rather large, higher than long. Nasals moderate. Upper labials 8; the 6th subtriangular, and smaller; the 7th and 8th largest of all, elongated, equal. Lower labials 9, the 5th largest.

Body very slender and attenuated. Dorsal rows of scales 17, all smooth, elongated, even the exterior row longer than broad.

Color anteriorly, above and on the sides black, this distinct for one-fourth of the length, fading gradually into brown, which becomes lighter and lighter towards the tail. Behind the black portion, the scales above are brownish yellow at their basal margin, the rest of the scale more or less mottled with the different shades of brown. The darkest tint is usually seen near the tip of the scales, this on the tail forming a distinct margin. Beneath, the color is yellowish white, on the anterior fifth so much blotched with purplish brown as to be nearly uniform, posterior to which it disappears almost entirely, being represented only by occasional dashes. The ends of each scutella, however, on their margins, exhibit the reddish brown blotches, and are colored much like the sides of the body at that place. The centres of all the plates beneath and on the sides of the head are yellow. Anteorbital mostly yellow.

S. Carolina. 202+2. 96. 17. 44. 10½. Dr. W. J. Burnett.

2. Masticophis flavigularis, B. & G.—Light dull yellow, tinged with brown above. Beneath, two longitudinal series of blotches distinct anteriorly. In alcohol, and especially when the epidermis is removed, the whole animal appears of a soiled white.

SYN. *Psammophis flavigularis*, HALLOW. Proc. Acad. Nat. Sc. Philad. VI, 1852, 178.

Size very large. Vertical plate broad before, tapering to the middle, where it is about half as wide as anteriorly, thence it runs nearly parallel. Vertical rather shorter than occipitals. Greatest breadth across superciliaries less than half the length of the portion covered by plates. Occipitals moderate. Centre of eye considerably anterior to the centre of commissure; over the junction of the 4th and 5th labials. Labials 8 above, increasing in size to the 5th, which is elongated vertically, the 7th elongate and largest. The 5th forms part of the inferior and posterior wall of the orbit, as in all the species of the genus, resting above against the lower postorbital, with which

the 6th labial is not in contact. Dorsal scales broader than in *Bascanion constrictor*, their sides perfectly straight, slightly truncate, with the corners rounded. Exterior row largest, rest gradually diminishing. Scales on the tail widely truncate.

The general color, both above and below, may be described as a dull straw-yellow, tinged with light olivaceous brown above. This latter tint exists in the form of a shading on the centres and towards the tips of the scales, leaving the bases yellowish. The proportion of brown increases towards the back, and in older specimens sometimes suppresses the yellow. In all instances a darker shade is seen towards the tip of each scale. The skin between the scales is yellowish. The scutellæ anteriorly exhibit each two rather large brownish blotches, one on each side of the median line, constituting two rows on the abdomen, which fade out posteriorly. Sometimes the series are not discernible, the blotches spreading so as to constitute a dark shade to the margins and exterior edges of the scutellæ. The posterior portions of the plates under, and on the sides of the head, are similarly blotched; the same tendency being observable on the posterior edges of the plates on the top of the head, by the deeper shade of the olivaceous brown there prevalent. Anteorbitals yellow.

Betw. San Antonio & El Paso.	193+2.	100.	17.	57¾.	17½.	Col. J. D. Graham.
"	196+1.	100.	17.	65½.	15½.	"
New Braunfels, Tex.	196+2.	94.	17.	69½.	15½.	F. Lindheimer.
Red River. Ark. ♂	191+2.	—	17.	57½.	—	Capts. Marcy & McClellan.

In smaller specimens the blotching beneath is rather more decided. In addition to the colors described, the back is crossed by indistinct bars of darker, eight or nine scales wide and half a scale long. This color is also seen on the skin between the scales under the dark bars, where the bases of the scales themselves are darker instead of light. There is a tendency towards stripes on the side: first one of light brown, on the outer edge of the abdomen; then an interrupted yellow one at the junction of the abdominal scutellæ and outer scales; then brown again through the centres of the rows. This, however, is not very conspicuous. Sometimes the dark shades on the sides are tinged with reddish. The obsolete transverse bars are seen at intervals of one or two scales.

Betw. Indianola & San Antonio.	197+2. 96.	17.	41½.	10.	Col. J. D. Graham.
Indianola.	194+2. 110.	17.	40.	10⅛.	"
"	197+2. 110.	17.	34¾.	9.	"

A specimen from Fort Webster or Copper Mines shows the stripes on the sides much more distinctly, running through all the dorsal rows anteriorly, and crossed by the indistinct bars already referred to. The contrast between the dark chestnut-brown spots on each side, and its deeper centre, with the clear yellow of the edges, is very distinct. Beneath yellow, with the blotches reduced to mere dull spots.

Santa Rita del Cobre 211+2. 101. 17. 39⅛. 10⅝. Col. J. D. Graham.

3. Masticophis mormon, B. & G.—Head rather short. Vertical plate with anterior and posterior ends nearly equal, concave between. Pale yellowish red, tinged with gray anteriorly. A series of transverse blotches across the back.

Syn. *Coluber mormon*, B. & G. Reptiles in *Stansbury's* Expl. of Valley of Great Salt Lake, 1852, 351.

The only specimen of this species in our possession is immature. Although belonging to a different genus, it is somewhat similar to the young of *B. constrictor*, though lighter. The occipitals and commissure of the mouth are, however, much shorter, the vertical and occipital nearly equal in length. Vertical, with the sides concave; dimensions anteriorly and posteriorly nearly equal. Scales not quite so broad as in *Bascanion Foxii*, though broader than in *B. constrictor*, especially on the anterior row. Above pale yellowish red, more grayish anteriorly. A series of transverse blotches from head to tail, as in *Bascanion constrictor*, though rather less distinct. Beneath yellowish, unspotted except on the outer edges. Stouter in its dimensions than the young of *Bascanion constrictor*.

Owing to the immaturity of the specimen, we have felt in doubt whether it should be referred to *Bascanion* or to *Masticophis*. The fact of the 5th labial being in contact with the lower postorbital has rather decided us in favor of the latter.

Great Salt Lake, Utah. 178+1. 100. 17. 13¾. 3½. Capt. H. Stansbury.

B. *Dorsal rows* 15. *Tail about* $\frac{1}{3}$ *the total length.*

4. Masticophis ornatus, B. & G.—Excessively elongated. Above very deep purple, brighter on the sides. Beneath mottled. A yellow stripe on each side of the abdomen, and two pairs of short yellow stripes, one behind the other, on the anterior part of the body, and in the 4th dorsal rows.

In this form the peculiar characters are carried to their maximum of development, and the species should be considered as the true type of the genus. The head is narrow, much elongated, and rather depressed; being considerably less arched than in *M. flagelliformis.* The vertical is very much elongated, a little shorter than the occipital. The muzzle is rather broad anteriorly, owing to the greater than usual development of the anterior frontals. The centre of the eye is considerably in advance of the commissural line, and behind the junction of the fourth and fifth labial. The upper anteorbital is very large, the lower still smaller than in the other species; in one specimen it is wanting. The sixth labial scarcely touches the postorbital; in one specimen being separated by a small plate. The loral is elongated, lower than in *M. flagelliformis.* Labials 8 above, penultimate largest; 9 or 10 below, the fifth largest. Rostral broader than high, the reverse being the case in *M. flagelliformis.* Dorsal rows of scales 15. The scales are broad, very large, thin, and perfectly smooth. The edges are nearly straight, tip truncated and rounded off. They are decidedly broader than in *M. flagelliformis.*

General color above dark purple, becoming almost black towards the back, brighter on the sides. The colors are deeper towards the head. Skin between the scales dark. Beneath yellowish, blotched with black. Anteriorly the blotches are in the form of two quite contiguous rows of broad mottled spots, which become broken posteriorly, and overspread the abdomen. Anteriorly these are dark brown, posteriorly they are lighter, and tinged with red. The tail is immaculated, reddish white. A distinct yellow line is seen along the outer edge of the scutellæ involving the lower edge of the exterior row of scales, and through the five exterior rows of purplish scales run stripes of darker; the bases of the scales being yellow. A very striking mark is to be seen in two pairs of short yellow stripes on each side, one pair commencing opposite to the 10th scutella, and running back about six scales; the second about opposite the 29th scutella, and running back about 10 or 12 scales. The mark is on

the fourth row and adjacent edges of the 3d and 5th. It is not entirely yellow, but has a light reddish stripe through its centre. There are faint indications of a repetition of these marks of similar character farther behind, but the specimens do not show them distinctly.

Betw. Indianola & El Paso.	203+2.	149.	15.	65½.	22.	Col. J. D. Graham.
"	204+2.	152.	15.	65.	22.	"

5. Masticophis tæniatus, B. & G.—A broad brown dorsal stripe margined by a darker line. The four outer rows of scales on each side yellow, with a dark line through the centre of each. A dark line along the edge of the abdomen, making six dark lines on each side. Beneath yellowish.

Syn. *Leptophis tæniata*, Hallow. Proc. Acad. Nat. Sc. Philad. VI, 1852, 181.

Owing to the mutilation of the head of the single specimen in our possession, it is impossible to describe this with any degree of accuracy; in its general relations, however, it has the plates much as in the preceding species.

A longitudinal dorsal band, six and two half-scales wide, olive-brown, each scale with a rather deeper spot in the centre; the four and a half scales on each side of this band yellow, each row with a narrow brown stripe through its centre, fading out in the tail. There are thus five dark stripes on each side, the fifth above margining the dorsal band. Of these stripes, the 1st and 3d are narrow, each showing a stripe of yellow of the same size on each side of it; the 2d and 3d are closer to each other and broader. Beneath yellowish, with a distinct dark stripe on each side, just within the external row of dorsal scales. The scutellæ otherwise immaculated, except a few scattered dots towards the head, exhibiting a tendency to arrangement in two rows. Extreme bases of all the scales black.

California.	209+2.	157.	15.	48½.	14.	Dr. W. Gambel.

Genus **SALVADORA**, Baird & Girard.

Gen. Char. Head elliptical, detached from the body by a contracted neck. Snout protruding. Cephalic plates normal. Edges of rostral free. Two nasals. One loral. Two, occasionally three anteorbitals and two postorbitals. Temporal shields small, scalelike. Eyes quite large. Two pairs of mental scutellæ. Tail slender. Body covered with smooth scales. Postabdominal scutella bifid. Subcaudal all bifid. Color diversified, in longitudinal bands.

Salvadora Grahamiæ, B. & G.—A dorsal ochraceous band or vitta, on each side of which a black one of the same width. Flanks yellowish green. Abdomen uniform dull yellow. Dorsal scales in 17 rows.

Head conical, rostral plate very prominent, with edges free, appearing as if fastened on the outside of the snout after all the others had taken their place. Prefrontals proportionally large, forming the upper edge of the nostrils, and widely separated, for the two anterior thirds of their length, by the rostral. Postfrontals but slightly larger than the prefrontals, like the latter, subrounded, longitudinally narrow, transversely elongated, and produced slightly between the postnasal and the loral, on the sides of the head. Vertical subpentagonal, much elongated, tapering posteriorly without being pointed. Occipitals elongated, posteriorly truncated, sides rounded. Prenasal larger, subtrapezoidal; postnasal subquadrangular; nostril situated at the antero-posterior angle of the postnasal. Loral subtriangular, base in an horizontal line with the head; apex upwards produced between the postfrontal and the upper anteorbital. Upper anteorbital large, angular, produced to the upper surface of the head between the superciliaries and postfrontals. Inferior anteorbitals small and quadrangular, lowest situated on the commissure between the 4th and 5th labials. Postorbitals angular, equal in size. Two pretemporals, shields somewhat larger than rest, which are scarcely larger than the scales. Mouth deeply cleft, undulating. Upper

labials 9; 7th largest, the 4 anterior ones comparatively small. Lower labials not conspicuous, 10 in number, 5th largest, the three posterior ones scarcely to be distinguished from the scales. Posterior pair of mental scutellæ much smaller than the anterior, extending to the middle of the fifth inferior labial.

Body subcylindrical, elongated, tail subconical, tapering, forming about the ¼ of the total length. Scales elliptical, disposed in 17 rows; outer row somewhat broader, the rest slightly diminishing towards the dorsal region.

Surface of head brown. An ochraceous vitta extends from the occiput to near the end of the tail, embracing anteriorly three rows of scales, and posteriorly one row, and two adjoining halves to opposite the anus; on the tail it covers two half scales. On each side of this a black vitta runs parallel, and covers the same number of scales anteriorly and posteriorly, except on the tail, where it is narrower, and embraces only half a scale. The antero-inferior margin of the scales in the black vitta is yellowish green. The remaining portion of the flanks, embracing four rows of scales, and the extremities of the scutellæ, is uniform yellowish green, with the bases of the scales blackish, as is also the skin. The abdomen is uniform dull yellow.

Sonora, Mex. 180+1. 97. 17. 28½. 7½. Col. J. D. Graham.

Genus **LEPTOPHIS**, Bell.

Gen. Char. Head conical, very much swollen on the temporal region, separated from the body by a very small neck, and tapering considerably on the snout, which is protruding. Cephalic plates normal. One nasal plate. One loral. One anteorbital and two postorbitals. Eyes large. Cleft of mouth deep and curved. Tail slender and very long, forming more than ⅓ of the total length. Scales in 17 rows, carinated, except the first and second rows, which are smooth. Postabdominal scutellæ bifid. Subcaudal all bifid. Unicolor.

Syn. *Leptophis*, Bell, in Zool. Journ. II, 1826, 328.

1. Leptophis æstivus, Holbr.—Body reddish green above; yellowish white beneath. Dorsal scales in 17 rows.

Syn. *Coluber æstivus*, Linn. Syst. Nat. I, 1766, 387.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1114.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 357; and Med. & Phys. Res. 1835, 121.

Leptophis æstivus, Bell, Zool. Journ. II, 1826, 329.—Holbr. N. Amer. Herp. III, 1842, 17. Pl. iii.

Anguis viridis, Catesb. Nat. Hist. Carol. II, 1743, 57. Pl. lvii.

Green Snake, Bartr. Trav. in Carol., Geo. and Flo., 1791, 16.

Head regularly ovoidal. Vertical plate elongated, subpentagonal, diminishing posteriorly, though not acute. Occipitals elongated, tapering posteriorly, and subtruncated. Frontals subrounded; prefrontals smaller than postfrontals by about one-fourth. Rostral rounded, broader than high. Nostril in the middle of the nasal. Loral subtrapezoidal. Anteorbital angular, much broader above than below. Postorbitals subangular, lower one the smallest. Superciliary well developed, irregularly oblong. A large pretemporal shield, and three or four smaller ones. Upper labials 7; 6th slightly the largest. Lower labials 8; 5th the largest. Posterior mental scutellæ slender and elongated, extending beyond the 5th lower labial.

Scales subelliptically elongated, strongly carinated except the outer row, which is perfectly smooth, and the 2d row, which is but slightly carinated. These two external rows are broader than the rest, especially the outermost.

Anderson, S. C.	157+1. 130. 17.	25½. 9⅝.	Miss C. Paine.
"	154+1. 134. 17.	24. 9⅜.	"
Kemper Co., Miss.	154+1. 128. 17.	27¾. 10⅞.	D. C. Lloyd.
"	154+1. 129. 17.	25. 10.	"
Virginia.	154+1. 126. 17.	33⅛. 8⅞.	
Anne Ar. Co., Md.	155+1. 135. 17.	21¾. 8½.	J. H. Clark.

2. Leptophis majalis, B. & G.—Reddish green above, yellowish white beneath. Body proportionally stouter and tail shorter than in *L. œtivus.* Snout and whole head, including vertical, longer than in latter species. Dorsal scales in 17 rows.

Head more pointed, broader on the temporal region, and more tapering on the snout than in *L. æstivus.* Vertical plate subhexagonal, broader, and postfrontals proportionally larger in comparison with the prefrontals, than in *L. æstivus.* Occipitals maintaining more their width posteriorly, obtuse-angled behind. Nasal more elongated; loral smaller, and longer than high. Two large temporal shields and a few small ones behind. Scales strongly carinated, except the outer row which is perfectly smooth, and the second row, which is but slightly carinated. The scales of both of these rows are broader than the rest.

Indianola, Tex.	163+1. 111. 17.	29⅝. 10.	Col. J. D. Graham.
"	156+1. 113. 17.	28¼. 10⅛.	"
Red River, Ark.	163+1. 111. 17.	28½. 9¾.	Capts. Marcy & McClellan.
New Braunfels, Tex.	154+1. 115. 17.	23⅜. 8¾.	F. Lindheimer.

Genus **CHLOROSOMA**, Wagl.

Gen. Char. Head elongated, ovoidal, separated from the body by a slender neck. Snout protruding. Cephalic plates normal. One nasal plate, with the nostril in the centre. One loral. One anteorbital; two postorbitals. Eyes very large. Mouth deeply cleft. Tail slender, between ⅓ and ¼ of total length. Scales all perfectly smooth. Postabdominal scutella bifid. Subcaudal all bifid. Unicolor.

Syn. *Chlorosoma*, Wagl. Nat. Syst. der Amph. 1830, 185.

Chlorosoma vernalis, B. & G.—Uniform green, darker above, lighter beneath. Dorsal scales in 15 rows.

Syn. *Coluber vernalis*, Dekay, Mss.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 361 ; and Med. & Phys. Res. 1835, 124.—Storer, Rep. Rept. Mass. 1839, 224.—Holbr. N. Amer. Herp. III, 1842, 79. Pl. xvii.—Dekay, N. York Fauna. Rept. 1842, 40. Pl. xi, fig. 22.—Thomps. Hist. of Verm. 1842, 117.
Green Snake.

Head proportionally long, ovoidal, slightly swollen on the temporal region. Snout rounded and projecting considerably over the lower jaw. The rostral plate shows but little from above. Outlines of frontals rounded, prefrontals proportionally large, and more than half the size of the postfrontals. Vertical hexagonal, elongated, posteriorly more tapering than anteriorly; sides slightly concave. Occipitals large, subangular. Superciliaries quite large, broader posteriorly than anteriorly. Postorbitals two, subquadrangular; lower one resting on the commissure of the 4th and 5th upper labials. Anteorbital angular above, rounded below, with anterior margin convex. Loral angular, longer than high, and proportionally well developed. Nasal elliptically elongated, with nostril in the middle. Three temporal shields, well developed; anterior one elongated, largest. Cleft of mouth curved or undulated. Upper labials 7;

4th largest; 5th and 6th nearly equal to the 4th; 3d and 4th beneath the eye, forming the inferior part of the orbit. Lower labials 8; 5th largest; the three anterior and three posterior ones quite small. Posterior pair of mental scutellæ longer and slenderer than the anterior pair, extending much beyond the 5th lower labial.

Body elongated, subcylindrical, a little deeper than broad, covered with smooth subhexagonal or subelliptical scales, constituting 15 longitudinal rows, the outer row broader than the rest, which diminish towards the middle line of the back. The tail is very much tapering, pointed, and forming about $\frac{1}{3}$ or $\frac{1}{4}$ of the total length Dark green above, lighter on the flanks; yellowish white beneath.

Westport, N. Y. ♀	138+1.	79.	15.	18.	$5\frac{1}{4}$.	S. F. Baird
"	137+1.	74.	15.	17.	5.	"
"	132+1.	94.	15.	$17\frac{1}{2}$.	$6\frac{1}{4}$.	"
Lebanon Sp., N. Y.	—	—	15.	15.	$5\frac{1}{2}$.	Wm. B. Parker.
"	—	—	15.	15.	6.	"
Carlisle, Pa.	130+2.	92.	15.	$18\frac{7}{8}$.	$6\frac{7}{8}$.	S. F. Baird.
"	130+1.	—	15.	$11\frac{1}{2}$.	4.	"
Racine, Wisc.	128+1.	85.	15.	$12\frac{1}{8}$.	$4\frac{1}{8}$.	Dr. P. R. Hoy.
Portland, Me.	—	—	15.	$19\frac{1}{2}$.	$5\frac{1}{2}$.	Prof. Caldwell.
"	—	—	15.	18.	$5\frac{1}{2}$.	"
Cambridge, Mass.	138+1.	79.	15.	$18\frac{5}{8}$.	$5\frac{1}{2}$.	J. H. Richard
"	—	—	15.	$6\frac{2}{8}$.	$1\frac{6}{8}$.	C. Girard
? ? *Mississippi.*	138+1.	69.	15.	$20\frac{1}{2}$.	—	Dr. B. F. Shumard

Genus CONTIA, Baird & Girard.

Gen. Char. Head ovoidal, and with the body much depressed, rather short, with the snout truncated. Cephalic plates normal. One nasal. Nostril in its middle. One loral. One anterior and one postorbital. Eye small. Mouth moderately cleft. Scales smooth. Postabdominal scutella bifid. Subcaudal all divided.

Contia mitis, B. & G.—Deep chestnut-brown above, with two longitudinal light bands, one on each side of the back, below which is a series of black dots. Scales minutely dotted with black. Anterior half of the scutellæ black; posterior half light yellow. Dorsal scales in 15 rows.

Head almost as deep as the body, snout protruding over the lower jaw, and obliquely truncated. Vertical plate hexagonal, sides nearly parallel, posteriorly very acute. Occipitals elongated, truncated posteriorly, slightly convex exteriorly. Postfrontals large and angular. Prefrontals subangular, much smaller. Rostral well developed, broad, but slightly produced between the prefrontals. Nasal quadrangular, longer than high, with nostril in the middle, a little nearer the anterior than posterior edge of the plate. Loral elongated and quadrangular, situated above the 2d labial. Anteorbital angular and elevated, situated above the 3d labial. Postorbital angular, larger than the anteorbital, situated above the commissure between the 4th and 5th labials. Superciliaries proportionally small and oblong. A large and angular elongated temporal shield. Upper labials 7; anterior and posterior ones smaller; 3d and 4th beneath the eye; lower labials 7, 4th largest. Posterior pair of mental scutellæ very small. Two scutellæ on each side, along the 5th, 6th, and 7th infralabials.

Body slender, subcylindrical, broader than deep. Scales proportionally large, subelliptical, posteriorly rounded or subtruncated. Those of the exterior row conspicuously broader. Tail short, conical, and tapering.

The lighter bands of the back cover the 4th exterior row of dorsal scales; the series of black dots is immediately beneath on the 3d row of scales. Tip of scales of exterior row black. Head above blackish brown, beneath mottled with black, on a yellowish green ground. The abdomen is regularly and transversely barred with black and light yellow.

San Jose, Cal.	167+1.	31.	15.	$12\frac{5}{8}$.	$1\frac{9}{16}$.	Dr. John L. Leconte.
California.	—	—	—	4.	$\frac{6}{8}$.	(on dep.) Expl. Exped.
Oregon.	154+1.	35.	15.	8.	$1\frac{5}{16}$.	Dr. Avery J. Skilton.

Genus **DIADOPHIS**, Baird & Girard.

Gen. Char. Head subelliptical, elongated, depressed, distinct from the body. Cephalic plates normal. Two postorbitals, and two anteorbitals. A well-developed loral. Two nasals; nostril between. Eyes large. Mouth deeply cleft. Body slender, subcylindrical; tail tapering. Scales smooth, disposed in 15 or 17 rows. Postabdominal scutella bifid. Subcaudal all divided. Unicolor above, and generally with a light ring on the occipital region. Abdomen lighter, unicolor, or punctate.

A. *An occipital ring. Eye above the 4th and 5th upper labials. Dorsal scales in 15 rows.*

1. Diadophis punctatus, B. & G.—A yellowish white occipital ring. Body bluish black above; yellowish orange beneath, with a medial series of spots, sometimes absent. Tail beneath unicolor. Dorsal scales in 15 rows.

Syn. *Coluber punctatus*, Linn. Syst. Nat. I, 1776, 376.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1089.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 354; and Med. & Phys. Res. 1835, 117.—Storer, Rep. Rept. Mass. 1839, 225.—Holbr. N. Amer. Herp. 2d ed. III, 1842, 81. Pl. xviii.
Spiletes punctatus, Swains. Nat. Hist. of Fish. Amph. & Rept. II, 1839, 364
Calamaria punctata, Schl. Ess. Phys. Serp. Part. descr. 1837, 39.
Ring-necked Snake.

Head very much depressed, flattened above; snout rounded, and overlapping the lower jaw. Vertical plate subpentagonal, tapering backwards, posteriorly acute. Occipitals large, elongated, subangular. Prefrontals irregularly rounded, posterior pair twice the size of the anterior. Rostral broad, but low. Nasal plates large, nostril intermediate. Loral quadrilateral. Two anteorbitals, inferior one narrow and the smaller. Superciliary well devèloped, broader posteriorly than anteriorly. Two postorbitals, inferior one very small, situated above the junction of the 5th and 6th upper labials. Temporal shields conspicuous, anterior one larger and elongated. Upper

labials 8; 7th the largest, 4th and 5th forming the lower part of the orbit. Lower labials 8; 5th the largest. Two pairs of mental scutellæ, extremity of the posterior pair extending beyond the 5th lower labial.

Body slender, subcylindrical; tail tapering. Scales subelliptical; outer row but slightly larger. Occipital ring of the width of two scales, sometimes narrower. Upper labials yellowish, like the lower jaw and inferior surface of head and abdomen. A series of dark subtriangular spots along the lateral margins of the scutellæ, and in contact with the dark color of the flanks. Abdomen either unicolor or provided with series of similar dark spots along its middle region, from the anterior third of the body to near the anus. The spots sometimes elongate transversely in the shape of bars across the abdomen.

Carlisle, Pa.	148+1.	53.	15.	13⅝.	3.	S. F. Baird.
"	158+1.	50.	15.	13.	2⅞.	"
"	158+1.	52.	15.	14.	3.	"
"	148+1.	44.	15.	11¼.	2⅛.	"
Foxburg, Pa.	161+1.	56.	15.	14⅛.	3⅝.	"
Pittsburgh, Pa.	159+1.	50.	15.	15⅝.	3⅛.	"
French Creek, Pa.	157+2.	36.	15.	13¼.	2⅛.	"
Lebanon Sp., N. Y.	—	—	15.	5.	1⅛.	Wm. B. Parker.
Georgia.	141+1.	48.	15.	10¼.	2⅜.	Maj. J. Le Conte.
Riceboro, Ga.	145+1.	36.	15.	10.	1¾.	Dr. W. L. Jones.

A specimen from Anderson, S. C., exhibits a somewhat slenderer head, and a narrower and more elongated vertical plate.

Anderson, S. C.	155+1.	44.	15.	14½.	2½.	Miss C. Paine.

Another very young specimen from Mississippi has a shorter head, and a vertical plate proportionally much broader and shorter.

Mississippi.	—	—	15.	5.	1⅛.	Dr. B. F. Shumard.

B. *An occipital ring. Eye above the 3d and 4th labials. Dorsal scales in 15 rows.*

2. Diadophis amabilis, B. & G.—Body above deep blackish brown; beneath yellowish white, with crowded small black spots. Occipital ring narrow. Dorsal scales in 15 rows.

Head, body, and tail very slender; head flattened above; body subcylindrical; tail subconical and tapering into a point. Vertical

plate subpentagonal, less tapering posteriorly than in *D. punctatus*, and subacute. Occipitals narrow and elongated. Frontals as in *D. punctatus*. Superciliaries narrower, and nearly of the same width throughout their length. Upper labials 7; 6th largest. Lower labials 8; 5th largest. Scales rather short, subelliptical, considerably larger on the sides than on the back, especially the outer row. Color of the abdomen extending to the outer row of scales, the posterior portion of which alone is black. Numerous small spots are scattered all over the lower part of the body, from the head to near the end of the tail. The upper surface and sides of head, as well as the labials of both jaws and chin, are blackish brown. The abdomen, in life, is in all probabilities purplish, judging of it from traces of that color left beneath the tail of one of the specimens preserved in alcohol.

San Jose, Cal.	182+1. 59. 15.	12½. 2$\frac{9}{16}$.	Dr. J. L. Leconte.
"	— — 15.	9½. 2.	"

3. Diadophis docilis, B. & G.—Body above uniform ash-gray; yellowish white beneath, spotted with black. A proportionally broad yellowish white occipital ring, margined with a narrow black line. Dorsal scales in 15 rows.

Head narrower than in *D. amabilis*. Vertical plate subpentagonal, elongated, sides nearly parallel to the point where it enters between the occipitals. Prefrontals and eyes proportionally much smaller than in *D. amabilis*. Body very slender, covered with proportionally large scales. Head above blackish brown. Upper labials and head beneath yellowish, mottled with black. Occipital ring yellowish white, covering the length of three scales. The anterior black margin passes to the black spots along the labials. Small black spots are irregularly scattered all over the abdomen; they form one series on each side, along the exterior and posterior margin of the scutellæ, to the tip of the tail. All the scales are uniform ash-gray, but when examined closely they appear punctured with minute black dots. The bases of the scales are black when stretched apart. The tail beneath is almost unicolor, exhibiting but very few dots.

R. San Pedro of R. Grande, or Devil's River.	193+1. 57. 15.	11⅞. 2⅛.	Col. J. D. Graham.

4. Diadophis pulchellus, B. & G.—Body above greenish brown, the scales minutely dotted with black. Beneath deep orange-red, with small black spots irregularly scattered all over, from head to near the end of tail. Occipital ring broad, margined anteriorly and posteriorly with a narrow black line. Dorsal scales in 15 rows.

Head small, body proportionally long and subcylindrical; tail conical, and very much tapering. The vertical plate is subpentagonal, and still less tapering, and less acute than in the preceding species. Superciliaries as in *D. amabilis.* Scales subelliptical, elongated. Outer rows larger than the rest, which diminish towards the dorsal line. The bright color of the abdomen extends to the two external rows of scales, which are unicolor, the spots of the abdomen scarcely passing beyond the scutellæ, although a series of very small spots may be followed along the upper edge of the 2d dorsal rows of scales close to the color of the back. The upper labial and lower jaw are yellowish white.

El Dorado Co., Cal. 203+1. 60. 15. 14$\frac{3}{4}$. 2$\frac{5}{8}$. Dr. C. C. Boyle.

C. *No occipital ring. Eye above the 3d and 4th labials. Dorsal scales in 17 rows.*

5. Diadophis regalis, B. & G.—Body above uniform greenish ash; beneath light yellow, scattered all over with small black spots. No occipital ring. Dorsal scales in 17 rows.

Head proportionally short and broad behind; head less depressed than in the preceding species, though flattened above; snout rounded. Eyes very small. Vertical plate subpentagonal, tapering posteriorly. Superciliaries narrower anteriorly. Body long and subcylindrical. Scales proportionally large and elongated, in 17 rows; those of the outer row conspicuously broader. The upper and lower jaws and inferior surface of head maculated with black, on a light ground. Color of the abdomen extending to the outer row of scales, which are dotted with black posteriorly. The black spots on the abdomen extend considerably beyond the anus.

Sonora, Mex. 237+1. 58. 17. 22$\frac{3}{4}$. 3$\frac{1}{8}$. Col. J. D. Graham.

Genus **LODIA**, Baird & Girard.

Gen. Char. Head ovoidal, distinct from the body. Two vertical plates; a small anterior one being situated between the postfrontals immediately in advance of the vertical proper. Two nasals. Loral entering into the orbit; above it one anteorbital. Postorbitals two. Superciliaries elongated and well developed. Mental scutellæ one pair. Eyes proportionally large, circular. Scales smooth. Post-abdominal scutella bifid. Subcaudal, all in pairs.

Lodia tenuis, B. & G.—Body dull brown above, bluish on the sides, with a longitudinal lighter stripe on each flank. Abdomen lighter; bases of scutellæ bluish. Tail beneath unicolor, with an external series of bluish spots. Dorsal scales in 15 rows.

Syn. *Calamaria tenuis*, B. & G. Proc. Acad. Nat. Sc. Philad. VI, 1852, 176.

Vertical plate hexagonal, as broad anteriorly as posteriorly. Anterior vertical ovoidal or subelliptical, intermediate between the postfrontals, which are angular and extend to the sides of the head. Prefrontals subtriangular, about half the size of postfrontals. Rostral broad and well developed. Occipitals subangular externally, proportionally large and elongated. Nasals large, nostrils in the middle, between both plates. Loral large, polygonal, elongated, situated above the commissure of the 2d and 3d upper labials, entering into the orbit as an inferior anteorbital. A quadrangular superior anteorbital, enclosed between the postfrontal, superciliary, and loral. Two angular postorbitals, inferior one resting on the commissure of the 4th and 5th labials. Superciliaries oblong. Temporal shields conspicuous, anterior one elongated and largest. Mouth deeply cleft. Upper labials 6; the three posterior ones a little larger than the three anterior. Lower labials 6; 4th largest. Mental scutellæ one pair. Body slender, subcylindrical; tail short, conical, and tapering. Scales proportionally large, rhomboidal, smooth, forming 15 dorsal rows; outer row but slightly broader than the rest.

Puget Sound, Or. 150+1. 33. 15. 8¼. 1¼. (on dep.) Expl. Exped.

Genus SONORA, Baird & Girard.

Gen. Char. Head continuous with the body, very much narrower on the snout. Cephalic plates normal. Vertical plate narrow anteriorly. Superciliaries proportionally large. One loral. One anteorbital and three postorbitals. Two nasals. Eyes proportionally large. Scales smooth. Postabdominal scutella bifid. Subcaudal, divided.

Sonora semiannulata, B. & G.—Body above annulated with jet black; tail completely annulated; intermediate space wider, orange-red on the dorsal region, greenish on the sides, with bases of scales blackish. Dorsal scales in 15 rows.

Snout subquadrangular, elongated. Vertical plate widening posteriorly to the occipitals. Occipitals elongated, margin irregular. Postfrontals angular, not reaching the orbit. Prefrontals trapezoidal, two-thirds of the size of the postfrontals. Rostral very much developed. Nostrils in the middle, between the two nasals. Loral elongated, horizontal, angular. Eyes circular. Superciliaries angular, lozenge-shaped. Anteorbital one, subcrescentic, narrow, resting on the third upper labial. Postorbitals three, angular, upper one largest, produced between the superciliaries and occipitals, and touching slightly the vertical. Three temporal shields, anterior one largest, and angular. Mouth deeply cleft, undulated. Upper labials 7; nearly equal in size; first and last smallest. Inferior labials 8; 4th largest. Body subcylindrical, covered with smooth scales, proportionally broad, and forming 15 rows, outer row but slightly broader. Tail tapering to a point.

Body above crossed with transverse jet-black bars, 25 from head to anus, extending between and involving the exterior rows, becoming narrower on the flanks: along the back 3 to 4 scales long. Space between the bars above orange-red, one scale wider than the black bars; on the sides greenish, with the base of the scales blackish. On the tail 6 black rings, continuous all around, covering 2 to 3 scales; intermediate space red-orange, 4 or 5 scales wide. Beneath uniform dull green, the black bars of the body not touching the scutellæ.

Sonora, Mex. 149+1. 39. 15. 9½. 1¾. Col. J. D. Graham

GENUS **RHINOSTOMA**, FITZ.

GEN. CHAR. Head small, subconical, pointed, continuous with the body. Rostral large, prominent. Two pairs of frontal plates. Vertical cordiform. One nasal; nostril in the middle. One loral. One anterior and two postorbitals. Superciliaries very small. Eyes small, over the 3d upper labial. Mouth small. Scales smooth, in 19 rows. Postabdominal scutella entire. Subcaudal scutellæ bifid.

SYN. *Rhinostoma*, FITZ. N. Class. Rept. 1826, 29.

Rhinostoma coccinea, HOLBR.—Body yellowish red (said to be crimson in life), crossed by pairs of black rings, enclosing each a yellow one.

SYN. *Coluber coccineus*, BLUM. in *Licht.* and *Voigt*, Magaz. V, 1788. Pl. v. —GM. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1097.—HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 356; and Med. & Phys. Res. 1835, 119.

Heterodon coccineus, SCHL. Ess. Phys. Serp. Part. descr. 1837, 102. Pl. iii, figs. 15 and 16.

Rhinostoma coccinea, HOLBR. N. Amer. Herp. III, 1842, 125. Pl. xxx.

Scarlet Snake.

Body slender, cylindrical, tense, and rigid. Dorsal scales rhomboidal, rather elongated. Vertical plate very large, cordiform or subhexagonal, almost as broad anteriorly as long; obtuse angled before, acute angled behind; the two outer sides short, parallel. Occipitals large, a little longer than the vertical. Postfrontals large; prefrontals much smaller. Rostral projecting forwards, acute, causing the snout to be pointed, not recurved nor compressed into a ridge as in *Heterodon.* Eye small, its centre over the 3d labial, and over the middle of the commissure. Postorbitals two; anteorbital one. The superciliaries are very small and narrow, in one specimen looking like an upper postorbital. One line of temporal shields. Loral small. One nasal; nostril situated in its centre, with a rounded groove to the lower edge, sometimes to the upper, apparently separating two nasals. Upper labials 6, the 3d constituting the greater portion of the orbit

below, with the lower postorbital resting upon it: all the labials nearly equal in size; 4th and 5th largest. Lower labials 8, 5th largest.

The back and sides are embraced by about 20 elongated longitudinal black rings (the 16th opposite the anus), their anterior and posterior sides on the dorsal line, their lateral resting on the outer dorsal row. Across the back the black is well defined and continuous, about two scales long; on the sides, however (from the 1st to the 3d rows), the black is interrupted more or less, sometimes reduced to a few scattered scales. The intervals between the successive rings are yellow, with the centres of the scales dusky (they sometimes have only a narrow margin of yellowish), and on the sides may be seen a distinct rhomboidal black spot opposite each dorsal light interval. This is sometimes broken up, and confused with the black of the rings on the sides. The large spaces enclosed by the rings themselves are yellowish red (said to be crimson in life), six to nine scales long, and about thirteen wide: they are variable in length, being larger at about the anterior third than elsewhere. Beneath uniform yellowish white. The first ring crosses just behind the occipital plates, and in front of it is a narrow black band crossing the middle of the occipitals, from one angle of the mouth to the other, sometimes connected with the first ring by a narrow black line. Rest of the head yellowish. Another specimen has 26 rings, the 20th opposite the anus.

Anderson, S. C.	169. 35. 19.	17½. 2.	Miss C. Paine.
Riceboro, Ga.	166. 45. 19.	18⅞. 2¾.	Dr. W. L. Jones.
Mississippi.	— — —	— —	Dr. B. F. Shumard.

A specimen from Prairie Mer Rouge has the whole lower wall of the orbit constituted by the 3d labial, with both anterior and posterior orbitals resting upon it. The vertical is more elongated. The anterior dorsal ring, instead of being continuous, is divided anteriorly, and the ends, after approximating, are bent back on the occipitals, and extend to the eye. The snout, too, seems rather more pointed.

Prairie Mer Rouge, La.	166. 36. 19.	13¾. 2¼.	Jas. Fairie

Genus **RHINOCHEILUS**, Baird & Girard.

Gen. Char. Head subelliptical, pointed on the snout, and separated from the body by a contracted neck. Rostral plate large, but not prominent above. Two pairs of frontal plates. Vertical hexagonal. Two nasals; nostrils intermediate. One loral. One anterior and two postorbitals. Superciliaries large. Eyes also large, over the 4th and 5th upper labial. Mouth large. Scales smooth, in 23 rows. Postabdominal scutella entire. Subcaudal scutellæ all undivided.

Rhinocheilus Lecontei, B. & G.—A dorsal series of quadrate black blotches, with the intermediate spaces of the same size, and pale red. Flanks variegated with yellowish and black; beneath lighter, unicolor.

Head distinct from the body; broad behind, nearly flat above. Vertical plate hexagonal, elongated, largest anteriorly, the lateral edges tapering, and constituting the longest sides of the figure. Superciliaries quite large. Occipitals subangular, proportionally small. Prefrontals large compared to the postfrontals. Rostral prominent forwards, rounded beneath, tapering upwards. Eyes large, over the junction of the 4th and 5th upper labials, about opposite the middle of the commissure. Postorbitals two, lower in notch between the 5th and 6th labials, although resting more on the latter. Anteorbital large, resting on the 4th labial, the 4th and 5th labials constituting equally the inferior part of the orbit. Loral elongated, horizontal, trapezoidal, well developed. Nasals apparently double, perhaps a single one very much excavated. Two temporal shields between the occipitals and labials. Labials 8 above, 7th largest; 8 below, 5th largest. Dorsal rows of scales 23, all perfectly smooth; scales rhomboidal, nearly equal, but rather narrow above. Abdominal scutellæ 206; posterior one entire. Subcaudal scutellæ 40, all entire.

The body is crossed by about 33 quadrate black blotches, the 27th opposite the anus. These are nearly of the same length, and of the same distance apart throughout, four scales long, and extending between the second external rows, where their sides are rather rounded or angulated. The black is very deep, and continuous on the four or five central rows of scales, whence to the flanks it is varied by having the centres of each scale reddish yellow. The intervals between the blotches are exactly the reverse; above they are uniform pale red, and on the sides the centres of each scale are black. Sometimes scattered black scales may be observed on the back in the light spaces. Beneath yellowish white, unspotted. The two outer rows of scales of the same color, but with a short black bar extending from the middle of each light and dark space, perpendicularly to the abdomen, the extreme edge of which is sometimes involved. The head and half its length behind are black, spotted with yellowish on the sides. The snout and labials yellowish, the plates margined with black.

San Diego, Cal. 206. 40. 23. 21. 2½. Dr. John L. Leconte.

Genus **HALDEA**, Baird & Girard.

Gen. Char. Head elongated, ellipsoid, distinct from the body. Prefrontal plate single. Postfrontals large, entering together with the loral into the orbit, thus suppressing the anteorbitals. Postorbital one. Two nasals. Eyes proportionally large, circular. Scales carinated. Postabdominal scutella bifid. Subcaudals divided. Unicolor.

Haldea striatula, B. & G.—Grayish brown above, soiled yellow beneath, (said to be reddish gray above, and salmon-colored beneath, in life). A narrow light chestnut band across the middle of the occipitals, spreading over the angle of the mouth. Dorsal scales in 17 rows.

Syn. *Coluber striatulus*, Linn. Syst. Nat. I, 1766, 375.—Gm. *Linn.* Syst. Nat. ed. xiii, I, iii, 1788, 1087.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 354; and Med. & Phys. Res. 1835, 117.

Calamaria striatula, Schl. Ess. Phys. Serp. Part. descr. 1837, 43.—Holbr. N. Amer. Herp. III, 1842, 123. Pl. xxix.

Brown Snake.

Vertical plate elongated, hexagonal. Occipitals proportionally very long, subround exteriorly. Prefrontal subtriangular. Portion of postfrontals seen from above, oblong, dilated on the face, and approximating the postnasal and upper part of the orbit. Rostral tapering upwards. Nostril opening in the posterior margin of the prenasal plate. Loral elongated, situated above the 2d and 3d labials, and forming, with the postfrontal, the anterior part of the orbit. Eyes circular. Superciliaries proportionally large. One angular postorbital, elevated, the fourth labial forming the lower portion of the posterior part of the orbit. Temporal shields of medium size. Mouth deeply cleft. Upper labials 5; 4th and 5th very large. Inferior labials 6; 5th disproportionally the largest.

Body slender, subcylindrical; tail short, and very much tapering. Scales lanceolated, in 17 rows, all carinated, very narrow along the back; outer row conspicuously broader, with an obsolete carination.

Richmond, Va.	128+1. 36. 17.	$9\frac{3}{4}$. $1\frac{3}{4}$.	C. W. Keesee.
"	129+1. 37. 17.	$7\frac{1}{4}$. $1\frac{5}{8}$.	"
Charleston, S. C.	126+1. 46. 17.	$9\frac{1}{4}$. $1\frac{7}{8}$.	Dr. S. B. Barker.
"	123+1. 46. 17.	$7\frac{3}{8}$. $1\frac{1}{2}$.	"
Kemper Co., Miss.	125+1. 44. 17.	$8\frac{1}{2}$. $1\frac{3}{4}$.	D. C. Lloyd.

GENUS **FARANCIA**, GRAY.

GEN. CHAR. Head subelliptical, elongated, slightly distinct from the body. Prefrontal plate single. One nasal, grooved beneath the nostril. No anteorbital; postfrontal and loral constituting the anterior portion of the orbit. Two postorbitals. Eyes rather small. Scales smooth. Postabdominal scutella bifid. Subcaudal in pairs.

SYN. *Farancia*, GRAY, Zool. Misc. 1842, 68; and Catal. of Snakes in Brit. Mus. 1849, 74.

Farancia abacurus, B. & G.—Body and head above bluish black, with subquadrate red spots on the flanks. Abdomen red, with transverse or alternating bluish black irregular spots. Dorsal scales disposed in 19 rows.

SYN. *Coluber abacurus*, HOLBR. N. Amer. Herp. I, 1836, 119. Pl. xxiii.
Homalopsis Reinwardtii, SCHL. Ess. Phys. Serp. Part. descr. 1837, 357.
Hydrops Reinwardtii, GRAY, Zool. Misc. 1842, 67.
Hydrops abacurus, DUM. & BIBR. Erp. Gen. —— Tab. 65.
Helicops abacurus, HOLBR. N. Amer. Herp. 2d. ed. III, 1842, 111. Pl. xxvi.
Farancia Drummondi, GRAY, Zool. Misc. 1842, 68.
Farancia fasciata, GRAY, Catal. of Snakes, Brit. Mus. 1849, 74.
Red-Bellied Snake; Horn Snake.

Vertical plate subhexagonal, elongated, sides nearly parallel, pointed posteriorly. Occipitals elongated, angular, posteriorly tapering. Postfrontals subangular, entering in the orbit. Prefrontal angular, well developed. Rostral much broader than high, concave beneath. Nostril in the middle of the nasal plate, visible from above. Loral elongated, horizontal, forming together with the postfrontal, the anterior part of the orbit. Eyes circular. Superciliaries subangular, elongated, well developed. Two angular postorbitals, upper one largest, lower one resting on the commissure between the 4th and 5th labials. One pretemporal shield, large, and four smaller ones. Upper labials 7; 5th and 6th slightly larger. Lower labials 8, 4th largest; the two posterior ones scale-like. Mental scutellæ two

pairs, nearly equal in length, posterior pair more tapering. Body subcylindrical, opalescent; tail proportionally short and conical. Scales perfectly smooth, rhomboidal; outer row somewhat broader than the rest. The five medial rows smaller.

Color uniform bluish black above. On the two outer rows the ground-color assumes the shape of vertical bands, from one and a half to two scales broad, leaving an intermediate space from two to three scales wide, which is red in life, and dull yellow in specimens preserved in alcohol. Both the red and bluish black extend on the abdomen, the former being the ground-color, and the vertical bands of the flank confluent on the middle of the abdomen, either directly opposite or alternating.

Anderson, S. C.	171+2.	47.	19.	31⅝.	5⅝.	Miss C. Paine.
Prairie Mer Rouge, La.	173+2.	47.	19.	30¼.	7⅝.	Jas. Fairie.
"	173+2.	47.	19.	16.	2¾.	"
"	—	—	19.	—	—	"
"	—	—	19.	—	—	"

Genus **ABASTOR**, Gray.

Gen. Char. Head subconical, continuous with the body. Cephalic plates normal. Vertical plate elongated. One nasal, grooved beneath the nostril. No anteorbitals. One loral together with the postfrontals constituting the orbit anteriorly. Two postorbitals. Eyes of medium size, circular. Scales smooth. Penultimate and last abdominal scutella bifid. Subcaudal all bifid.

Syn. *Abastor*, Gray, Catal. of Snakes in Brit. Mus. 1849, 78.

Abastor erythrogrammus, Gray.—Bluish black, opalescent, with three longitudinal lines of dull yellow (red in life). Abdomen dull yellow (flesh-colored in life), with a series of bluish-black spots on each side. Dorsal scales in 19 rows.

Syn. *Coluber erythrogrammus*, Daud. Hist. Nat. Rept. VII, 1799, 93. Tab. 83, fig. 2.—Holbr. N. Amer. Herp. 1st ed. I, 1836, 115. Pl. xxii.
Helicops erythrogrammus, Wagl. Nat. Syst. Amph. 1830, 170.—Holbr. N. Amer. Herp. 2d ed. III, 1842, 107. Pl. xxv.
Homalopsis erythrogrammus, Boie, Isis. 1827, 551.
Abastor erythrogrammus, Gray, Catal. of Snakes in Brit. Mus. 1849, 78.

Vertical plate subhexagonal, long, maintaining its width posteriorly to the point where it enters between the occipitals. Occipitals long, anteriorly and posteriorly angular, rounded exteriorly. Postfrontals polygonal, entering into the orbit. Prefrontals proportionally small and subtriangular. Rostral very broad. Nostril in the middle of the nasal, with a groove beneath. Eyes very large. Loral narrow, forming with the postfrontals the anterior portion of the orbit. Superciliaries large, elongated, sides undulated. Two rounded postorbitals, lower one smallest. A very long temporal shield extending backwards beyond the occipitals, and two or three smaller ones, scarcely distinguishable from the scales. Mouth deeply cleft. Upper labials 7, 6th larger; lower labials 7; 4th larger. Two pairs of

mental shields, posterior pair smallest, extending backwards beyond the 4th inferior labial. Scales subrhomboidal, smooth, constituting 19 longitudinal rows; outer rows considerably larger, the other nearly equal amongst themselves, except the second row, which is somewhat larger.

Ground-color above bluish black. Dorsal longitudinal red line narrow, embracing only the medial rows of scales, extending from the occipitals to a little way beyond the anus. On each side of this there are three rows of scales of the ground-color. Then a longitudinal red line, broader than the medial one, though covering only one row of scales, then again three rows of the ground-color. Of the remaining two outer rows of scales, the outermost is uniform reddish yellow, and the bases of the scales of the second row have a spot of bluish black. Beneath, two series of bluish black subelliptical and transverse spots, one spot on the exterior third and anterior margin of each scutella. The plates of the head are narrowly margined with yellow. The labials are yellow, with a central black spot.

Southern States. (?)	182+1.	37.	19.	$15\frac{3}{4}$.	$2\frac{3}{8}$.	Rev. J. G. Morris.
"	185+1.	—	19.	$14\frac{3}{4}$.	$\frac{7}{8}$.	"
Savannah, Ga.	179+1.	41.	19.	10.	$1\frac{1}{2}$.	R. R. Cuyler.
"	179+1.	37.	19.	10.	$1\frac{3}{8}$.	"

Genus **VIRGINIA**, Baird & Girard.

Gen. Char. Head subelliptical, detached from the body. Cephalic plates normal. Two nasals; posterior one not invaded by the nostril. Postfrontals and loral entering into the orbit, and suppressing the anteorbitals. Two postorbitals. Mental scutellæ two pairs. Eyes of medium size, circular. Scales smooth. Postabdominal scutella bifid. Subcaudal all divided.

Virginia Valeriæ, B. & G.—Yellowish or grayish brown above, with minute black dots irregularly scattered, or constituting two series. Beneath lighter. Dorsal scales in 15 rows.

Vertical plate hexagonal, more or less elongated; occipitals oblong, exteriorly rounded. Postfrontals irregularly angular, produced into the orbit. Prefrontals subtriangular, proportionally small. Rostral narrow, and tapering upwards. Nostrils in the middle of the posterior margin of the prenasal. Loral elongated, forming together with the postfrontals, the anterior portion of the orbit. Eyes circular. Superciliaries rather large, oblong, elongated. Postorbitals two (angular), lower one between the 4th and 5th labials. Mouth deeply cleft. Upper labials 6, 5th largest; inferior labials 6, 4th largest. Temporal shields four or five, well developed. Body slender, subcylindrical, flattened beneath; tail very short, diminishing very rapidly towards its acute tip.

The scales are subrhomboidal and perfectly smooth; the two outer rows considerably broader than the rest, then diminishing gradually towards the middle line of the back.

Ground-color uniform yellowish or grayish brown; dull yellow beneath. Minute black dots are in most cases scattered along the upper part of the body, forming sometimes two longitudinal series. Along the middle of each scale is a faint light line, which makes the

body appear as if striated. On the outer rows this light line is broader, and appears as a succession of oblong spots.

Kent Co., Md.	127+1. 25. 15.	$9\frac{3}{8}$.	$1\frac{1}{4}$.	Miss V. Blaney.
Maryland.	122+1. 36. 15.	$7\frac{7}{8}$.	$1\frac{1}{8}$.	Prof. C. B. Adams.
Washington, D. C.	123+1. 25. 15.	$7\frac{1}{2}$.	1.	(on dep.) J. Varden.
"	125+1. 24. 15.	$8\frac{1}{8}$.	$1\frac{1}{8}$.	"
"	128+1. 25. 15.	$10\frac{7}{8}$.	$1\frac{1}{2}$.	"
"	125+1. 29. 15.	$8\frac{1}{4}$.	$1\frac{1}{8}$.	"
Anderson, S. C.	125+1. 27. 15.	$8\frac{1}{2}$.	$1\frac{1}{8}$.	Miss C. Paine.
"	118+1. 25. 15.	$7\frac{1}{8}$.	1.	"

Genus **CELUTA**, Baird & Girard.

Gen. Char. Head elongated, subelliptical, continuous with the body. Cephalic plates normal. Vertical broad. Superciliaries very small. One nasal, nostril in the middle. No anteorbital. Orbit formed chiefly by the loral, which is large, and slightly by the postfrontals. Scales smooth. Postabdominal scutella bifid. Subcaudals divided. Unicolor.

Differs from *Brachyorrhos* in having two pairs of frontals, and smooth scales.

Celuta amœna, B. & G.—Above uniform chestnut-brown, opalescent; light yellow (bright salmon-color in life) beneath. Dorsal scales in 13 rows.

Syn. *Coluber amænus*, Say, Journ. Acad. Nat. Sc. Philad. IV, 1825, 237.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 355; and Med. & Phys. Res. 1835, 118.—Storer, Rep. Rept. Mass. 1839, 226.

Calamaria amœna, Schl. Ess. Phys. Serp. Part. descr. 1837, 31. Pl. i, figs. 19 and 20.

Brachyorrhos amænus, Holbr. N. Amer. Herp. III, 1842, 115. Pl. xxvii.

Ground Snake; Worm Snake.

Head very small; vertical plate hexagonal, nearly as broad as long. Prefrontals angular, one-third the size of postfrontals, which are likewise angular, and enter posteriorly into the upper portion of the orbit in front. Occipitals proportionally large. Rostral broad, and well developed. Nasal single, nostril in the middle of the anterior half. A large loral forming with the postfrontal the anterior part of the orbit. A quadrangular and elevated postorbital. Superciliaries very small and narrow. Snout protruding. Eyes circular, over the commissure of the 3d and 4th labial. Upper labials 5, 5th largest. Inferior labial 6, 3d largest. Temporal shields well developed.

Body very glossy, subcylindrical. Tail short, tapering into a point. Scales rhomboidal, broad, all perfectly smooth. Outer row somewhat larger. Postabdominal scutella bifid.

The specimen figured by Schlegel, and which he had from Tennessee, exhibits only one pair of frontal plates, whilst the numerous specimens from the eastern part of the United States, examined by us, are all provided with two such pairs. Of two specimens from Missssippi, one corresponds exactly with the figure given by Schlegel, whilst the other has three frontal plates, a posterior pair, and the right plate of the anterior pair. This circumstance has warned us against distinguishing, for the present, a western species from an eastern. Schlegel had ten individuals in his possession, but we are not told whether they all agreed together, as no importance is given by that author to the presence of one pair of frontals only. Should all the western specimens agree in the deficiency of the prefrontals, this would undoubtedly become a character of some importance.

Carlisle, Pa.	128+1.	30.	13.	$11\frac{3}{4}$.	$1\frac{5}{8}$.	S. F. Baird.
"	120+1.	36.	13.	$8\frac{3}{8}$.	$1\frac{1}{2}$.	"
"	131+1.	29.	13.	$10\frac{1}{4}$.	$1\frac{1}{2}$.	"
"	120+1.	33.	13.	$6\frac{3}{4}$.	$1\frac{1}{4}$.	"
Foxburg, Pa.	119+1.	26.	13.	7.	$\frac{15}{16}$.	"
Washington, D. C.	131+1.	28.	13.	$10\frac{3}{8}$.	$1\frac{3}{8}$.	J. Varden.
Mount Vernon, Pa.	129+1.	27.	13.	12.	$1\frac{1}{2}$.	W. B. Parker.
Clarke Co., Va.	131+1.	24.	13.	$10\frac{13}{16}$.	$1\frac{3}{8}$.	Dr. C. B. Kennerly.
Anderson, S. C.	131+1.	28.	13.	$10\frac{7}{8}$.	$1\frac{9}{16}$	Miss C. Paine.
"	126+1.	27.	13.	$10\frac{1}{8}$.	$1\frac{3}{8}$.	"
"	130+1.	26.	13.	$10\frac{1}{2}$.	$1\frac{1}{2}$.	"
Mississippi.	120+1.	33.	13.	$8\frac{3}{4}$.	$1\frac{11}{16}$.	Dr.B.F.Shumard.
"	121+1.	35.	13.	$8\frac{1}{8}$.	$1\frac{1}{2}$.	"

Genus **TANTILLA**, Baird & Girard.

Gen. Char. Head slender, continuous with the body. Cephalic plates normal. Postfrontals proportionally large, separated from the labials to which they approximate, between the postnasal and anteorbital. Two nasals, nostrils in the anterior plate. No loral. Anterior orbital one; posterior one or two. Eyes below the medium size. Body slender, subcylindrical; tail tapering. Scales smooth in in 15 rows. Postabdominal scutella bifid. Subcaudal all divided. Unicolor.

1. Tantilla coronata, B. & G.—One anteorbital, two postorbitals. Body uniform reddish brown; head deep chestnut-brown, with a black band across the neck above, in advance of which is a narrow lighter space.

Snout prominent. Vertical plate hexagonal, anteriorly and posteriorly acute. Occipitals slender, rounded exteriorly. Postfrontals angular, excluded from the orbit, though extending on the sides of the head. Prefrontals triangular. Rostral proportionally broad. Nostrils situated on the posterior margin of the prenasal plate, and visible from above. Postnasal elongated, contiguous anteriorly to the anteorbital plate, and above to the postfrontal. No loral plate. Eyes rather small, circular. Superciliaries proportionally large, angular. Anteorbital one; postorbitals two, all angular. A large pretemporal shield, and two smaller ones behind. Mouth deeply cleft. Upper labials 7; 7th the largest; 3d and 4th beneath the eye. Inferior labials 7; 4th the largest. Mental scutellæ one pair. Body slender, tail rather short, tapering into a point. Scales subelliptical, considerably broader in outer row.

Ground-color of body uniform reddish brown; light beneath. Head deep chestnut-brown; upper part of neck with a blackish brown half-ring, covering 3 scales in length, between which and the head a narrow space of the ground-color exists, across the tip of the occipitals.

Kemper Co., Miss. 143+1. 35. 15. $8\frac{3}{4}$. $1\frac{5}{16}$. D. C. Lloyd.

2. Tantilla gracilis, B. & G.—Anterior and postorbitals one each. Color uniform greenish brown above, lighter beneath; head darker.

Vertical plate subhexagonal, much shorter than in *T. coronata.* Postfrontals separated from 2d upper labial by the postnasal. Nostril in the postmargin of the prenasal. Eyes very small and circular. Superciliaries proportionally smaller and narrower than in *T. coronata.* One anteorbital and one postorbital, both angular. Mouth deeply cleft. Upper labials 6; 5th and 6th equally larger than the rest; 3d and 4th beneath the eye, entering slightly into the orbit anteriorly and posteriorly. Temporal shields two, narrow and elongated. Body slender and subcylindrical, covered above with subrhomboidal or elliptical and smooth scales, constituting 15 rows; outer row but slightly larger than the three or four succeeding rows. Tail very slender.

Ground-color uniform greenish brown, lighter beneath. Head darker.

Indianola.	129+1. 45. 15.	$7\frac{1}{4}$. $1\frac{5}{8}$.	Col. J. D. Graham.
"	— — 15.	— —	"

Genus **OSCEOLA**, Baird & Girard.

Gen. Char. Head subelliptical, distinct from the body. Cephalic plates normal. Vertical hexagonal. Postfrontals very large, extending to the upper labials, and suppressing the loral. Two nasals, with nostril intermediate. One anterior and two posterior orbitals. Mental scutellæ 2 pairs. Eyes large. Body slender, subcylindrical. Tail tapering. Scales smooth. Postabdominal scutella entire. Subcaudal bifid.

Osceola elapsoidea, B. & G.—Body red, crossed by pairs of black rings enclosing each a white one. Scales disposed in 19 rows.

Syn. *Calamaria elapsoidea*, Holbr. N. Amer. Herp. III, 1842, 119. Pl. xxviii.

Snout projecting over the lower jaw; mouth deeply cleft. Vertical plate hexagonal, longer than broad anteriorly. Occipitals large, elongated, and angular. Postfrontals very large, extending to the 2d upper labial. Prefrontals proportionally well developed and trapezoidal. Rostral very broad. Nostrils very large, occupying the whole inner margin of the nasals, and visible from above. Anteorbital narrow, resting on the 3d labial. Middle of the eye over the commissure of the 3d and 4th labial. Two angular postorbitals, inferior one situated on the commissure, between the 4th and 5th labials. One large temporal shield, anterior, several posterior ones smaller. Upper labials 7, 6th largest; inferior labials 7, 5th largest

Body subcylindrical, deeper than broad; tail forming about the eighth of the total length. Scales rhomboidal, perfectly smooth, constituting 19 rows; the outer row slightly broader than the rest.

Ground-color brilliant red above, fading below, annulated with 15 pairs of jet-black rings from head to anus, and three pairs on the

tail, each pair enclosing a white ring. Head from the eyes to the snout red, vertical plate maculated with black. A black bar across the occipitals to the temporal shields, and another on the neck, between which a yellowish ring, narrow above, and spreading over the angle of the mouth, post upper labials and inferior surface of the head. The black rings cover from two to three scales, and the intermediate white, one scale. The red spaces between the black embrace from 4 to 7 scales. The black rings taper towards the sides, whilst the white ones are spreading.

Charleston, S. C. 175. 44. 19. 17$\frac{3}{8}$. 2$\frac{3}{4}$. Dr. S. B. Barker.

In a specimen from Mississippi there are 21 pairs of black rings from the head to the anus, narrower than in the specimen from Charleston, and interrupted on the abdomen. The intermediate white is of about the same width in each. On the tail there are 5 pairs of black rings, all the rings at the same distance apart, and equal in width to their interspaces.

Mississippi. 180. 54. 19. 17. 2$\frac{3}{4}$. Dr. B. F. Shumard.

Genus **STORERIA,** Baird & Girard.

Gen. Char. Head subelliptical, distinct from the body. Cephalic plates normal. Loral plate absent. Orbitals, two posterior; one or two anterior. Nasals two, rather large. Body small, scarcely exceeding a foot in length, subcylindrical; tail comparatively short, tapering. Dorsal scales 15–17 rows, all carinated. Abdominal scutellæ 120–140; posterior one bifid. Subcaudal, all divided, from 41 to 51 in number. Color brown, with two dorsal dotted lines.

1. Storeria Dekayi, B. & G.—One anterior and two posterior orbitals. Dorsal rows 17. Gray or chestnut-brown above, with a clay-colored dorsal band, margined by dotted lines. A dark patch on each side of the occipital; a dark bar between this and the eye, and two below the orbit.

Syn. *Tropidonotus Dekayi*, Holbr. N. Amer. Herp. III, 1842, 53. Pl. xiv. —Dekay, N. York Fauna. Rept. 1842, 46. Pl. xiv, fig. 30.
Tropidonotus ordinatus, Storer, Rep. Rept. Mass. 1839, 223.

Body rather thick in the middle, tapering to the tail and head, both of which are small and slender. Eyes small. Nostril principally in the prenasal. Seven upper labials on each side. Lower labials seven, of which the 4th and 5th are very large, extending quite to the mental. A second plate parallel with the 6th, rather longer. Exterior dorsal row of scales largest, rest diminishing gradually to the back.

Color grayish brown, sometimes chestnut-brown above and on the sides, with a dorsal stripe extending from occiput to the end of the tail, of a decidedly lighter tint, and about three and two half-scales in width. This is bordered along each outer edge by a series of rounded brown dots, occurring at intervals of about two scales; of these there are about 70 pairs from occiput to anus. Each dot occupies generally a single scale, but is sometimes seen on the skin on each side. On separating the scales, the skin on each side of the 4th lateral row of scales exhibits a second series, similar to and

alternating with the first. A third series opposite to the first and alternating with the 2d, is seen along the 2d row, and there are even traces of a fourth between the abdominal and first dorsal series. Of these only the first-mentioned series is visible under ordinary circumstances, and is generally only to be made out on separating the scales, the color only occasionally being shown on their margins. The first pair of dots just behind and across the angle of the jaw is enlarged into a crescentic patch, concave before. A second narrow vertical patch of black across the sides of the head, anterior to a point halfway between the first and the eye; this sometimes interrupted in the middle. The posterior margins of the 3d and 4th (sometimes the 2d) labials black, showing two vertical lines below the orbit. Plates on top of head mottled chestnut-brown.

Color beneath grayish white, with one or two black specks near the exterior edge of each scale. Tail unicolor.

In some specimens the brown of the sides increases in depth to the dorsal stripe. In some, too, a transverse bar connects the lateral spots across the back.

In a very young specimen from Grosse Ile, the colors are dark chestnut above, with the interval between the occipital patches and the cephalic plates and orbit white, crossed by a vertical black line on the angle of the mouth. Length 4½ inches.

Racine, Wisc.	128+1.	47.	17.	13.	2⅝.	Dr. P. R. Hoy.
Grosse Ile, Mich.	125+1.	50.	17.	8¼.	1¾.	Rev. Chas. Fox.
Cleveland, Ohio.	131+1.	48.	17.	11½.	2¼.	Dr. Kirtland.
Westport, N. Y.	123+1.	61.	17.	10¾.	2¾.	S. F. Baird.
Harrisburg, Pa.	120+1.	—	17.	7¾.	2½.	"
Framingham, Mass.	127+1.	45.	17.	11¼.	2¼.	"
Pittsburgh, Pa.	—	—	—	—	—	G. W. Fahnestock.
Washington, D. C.	129+1.	41.	17.	12.	2¼.	S. F. Baird.
Anderson, S. C.	120+1.	—	17.	9½.	3¼.	Miss C. Paine.
"	130+1.	47.	17.	12¼.	2¼.	"
Georgia.	136+1.	49.	17.	—	—	Major Leconte.
New Orleans. ?	124+1.	46.	17.	11.	2.	J. Varden.
New Braunfels, Tex.	—	—	—	—	—	F. Lindheimer.

2. Storeria occipito-maculata, B. & G.—Orbitals 1, two anterior, two posterior. Dorsal scales in 15 rows. Above gray, or chestnut-brown, sometimes with a paler vertebral line; beneath red or salmon-color. Three distinct light colored spots behind the head, and a smaller one on the 4th or 5th upper labial.

SYN. *Tropidonotus occipito-maculatus*, STORER, Rep. Rept. Mass. 1839, 230.
Coluber venustus, HALLOW. Proc. Acad. Nat. Sc. Philad. III, 1847, 274; and vol. IV, 1849, 245.

Nostril almost entirely in the prenasal plate, in some cases the postnasal not entering at all into it. Five to six upper labials, increasing in length posteriorly, lower labials 6 to 7, similarly constituted. Vertical plate hexagonal, shield-shaped. Muzzle rather broad, eyes larger than in *S. Dekayi*.

Color above light chestnut-brown, sometimes chestnut-gray, at others olivaceous: a paler vertebral line from occiput to end of tail, about three scales in width; on each side of this may be seen a series of minute brown spots, produced by the brown bases of the scales in the 3d row on each side from the central series. Sometimes the brown covers the whole scale, and gives rise to two dorsal lines; at others it is almost entirely wanting, and this, connected as it generally is with a less distinct vertebral band, gives the impression of a uniform tint above. Upper margin of the exterior dorsal lines brighter yellowish, giving the effect in some cases of a lateral narrow light line. Abdomen in life salmon-color, in alcohol whitish yellow, with the sides finely mottled with dark-brown, sometimes obsoletely, at others constituting very distinct bands. These generally do not encroach upon the dorsal scales. Occasionally, however, the middle of the exterior row of scales exhibits a dark stripe. Immediately behind the occipital plates, and on the median line, is seen a dull salmon-colored blotch, on each side of which, over the angle of the jaws, is a similar smaller one. The intervals between these blotches sometimes darker. A small salmon-colored spot on the 4th or 5th upper labial, behind the orbit. Plates on the top of the head blotched with darker. Lower jaw minutely dotted with brown.

Description of a living specimen caught at Westport, N. Y., August, 1847.—"Iris dark chestnut, rather lighter above and externally. General color above dull chestnut-brown. Attentively examined, however, when wet, there is seen a faint dorsal stripe of

lighter color, bordered by a line on each side of darker, which fades off to the abdominal scutellæ until the color is the same as the dorsal line, or even lighter. Behind the head are three light yellowish brown occipital spots. Whole under parts, except the chin or throat, bright brick-red. Chin and throat white, mottled finely with gray and black, like pepper and salt. An irregularly defined stripe of the same mottling along the sides, from head to anus, crossing the abdominal scutellæ near the outside."—S. F. Baird, Mss.

Westport, N. Y.	124+1.	43.	15.	9¼.	1¾.	S. F. Baird.
Portland, Me.	—	—	—	—	—	Prof. Caldwell.
Lake Superior.	—	—	—	—	—	Prof. Agassiz.
Racine, Wisc.	—	—	—	—	—	Dr. P. R. Hoy.
Foxburg, Pa.	—	—	—	—	—	S. F. Baird.
Madrid, N. Y.	128+1.	50.	15.	11.	2¼.	E. A. Dayton.
Pittsburgh, Pa.	—	—	—	—	—	G. W. Fahnestock.
Pottsville, Pa.	—	—	—	—	—	Mr. Sheafer.
Charleston, S. C.	—	—	—	—	—	Dr. S. B. Barker.
Anderson, S. C.	—	—	—	—	—	Miss C. Paine.
Georgia.	—	—	—	—	—	Major Leconte.

A very strongly marked variety, which the condition of the specimens does not allow us to characterize or determine as a species, is seen in individuals from Charleston and Anderson, S. C., in which the body is dark slate-blue, except the middle third of the abdomen, which is yellowish white. The dorsal lines of black dots are visible through the ground-color; the lateral lighter line is scarcely perceptible. The three occipital spots, and that on the labials, are distinct.

Charleston, S. C.	—	—	—	—	—	Dr. S. B. Barker.
Anderson, S. C.	125+1.	53.	15.	8¼.	2½.	Miss C. Paine.
Near Mammoth Cave, Ky.	118+1.	47.	15.	8½.	2.	Dr. B. F. Shumard.

Another variety is seen in a specimen from Pittsburgh, Pa., where, in addition to the coloration just mentioned, the vertebral stripe is light chestnut, contrasting strongly with the ground-color.

Genus **WENONA**, Baird & Girard.

Gen. Char. Head small, conical, slightly swollen on the temporal region, though not separated from the body by a contracted neck. Snout protruding beyond the lower jaw. Mouth moderately cleft. Eyes very small. A broad and short vertical; two or three pairs of frontals. Occipitals very small, the size of the superciliaries. One nasal, a posterior one; nostril between it and the prefrontals, which extend over the place occupied elsewhere by the prenasal. Loral united with postfrontals or separated. One very large anteorbital; two or more postorbitals. Numerous small temporal shields. Scales very small, lozenge-shaped, smooth, in 45 dorsal rows. Postabdominal scutella not divided. Subcaudal all entire. Unicolor. Tail proportionally short, stout, terminating blunt.

Syn. *Wenona*, B. & G. Proc. Acad. Nat. Sc. Philad. VI, 1852, 176.

1. Wenona plumbea, B. & G.—Uniform bluish lead-color above; uniform yellowish white beneath. Three pairs of frontal plates. Middle pair united with the loral, and thus extending to the labials. Labials not entering into the orbit. Dorsal scales in 45 rows.

Syn. *Wenona plumbea*, B. & G. Proc. Acad. Nat. Sc. Philad. VI, 1852, 176.

Upper surface of head slightly convex, snout rounded and prominent. Vertical plate as broad as long, obtuse angled anteriorly, rounded posteriorly. Postfrontals small and triangular, the smallest of all the frontals. Middle frontals subangular, transversely elongated, reaching the labials at the commissure of the 2d and 3d, occupying the place of the loral. Prefrontals angular posteriorly, rounded anteriorly, reaching the first labial, and occupying the place of the prenasal. Rostral broad and large. Postnasal subtriangular, elongated, apex directed backwards. Nostril vertically elongated, situated between the lateral expansion of the prefrontals and the postnasal. Occipitals quite small, and united in one plate,

perhaps accidentally. Anteorbital subpyramidal, apex reaching the upper surface of head, touching the vertical, and produced between the superciliaries and postfrontals. Superciliaries subquadrangular, more developed on the surface of the head than in the orbit. Three postorbitals, with rounded margins, upper one slightly the largest, situated near the upper surface of head, and might be considered as a second superciliary. Two suborbitals; anterior larger, subhexagonal, situated above the commissure between the 4th and 5th labials; posterior rounded, oblong, above the posterior half of the 5th labial. Temporal shields numerous and small, scalelike. Cleft of mouth slightly arched upwards. Upper labials 9; three anterior ones much higher than the rest; 5th broadest, none reaching the orbit. Lower labials inconspicuous; three anterior ones the largest.

Body subcylindrical, deeper than broad; abdomen comparatively narrow. Tail short, thick, blunt at its extremity. Scales small, irregular, subelliptical, or sublozenge-shaped; on the outer row very large proportionally, higher than long. In the 2d row the scales are still larger; but in the remaining rows they become uniformly small, scarcely diminishing towards the middle line of the back. On the tail, however, they are somewhat larger.

Puget Sound, Or. 206. 37. 45. 17⅝. 2½. (on dep.) Expl. Exped.

2. Wenona isabella, B. & G.—Uniform isabel-color above, dull yellow beneath. Two pairs of frontal plates. An angular loral. Upper 4th and 5th labials entering into the orbit. A small anterior vertical between the postfrontals. Dorsal scales in 45 rows.

Syn. *Wenona isabella*, B. & G. Proc. Acad. Nat. Sc. Philad. VI, 1852, 176.

Upper surface of head flat, snout subtruncated. Vertical broader than long, rounded posteriorly. A small second vertical between the postfrontals. Occipitals united in one small narrow plate. Two pairs of frontals only; postfrontals much larger, subrounded, forming on the right side a continuous plate with the loral, whilst on the left side the loral is distinct from the postfrontal which itself is angular. Prefrontals subangular, extending to the first upper labial, and occupying the place of the prenasal. Rostral broad, obtuse angled above. Anteorbital pyramidal, extending to the surface of the head, produced between the postfrontals and superciliary, and touching the vertical. Superciliary proportionally larger than in *W. plumbea*,

irregularly rounded. Three subangular and polygonal postorbitals. Numerous temporal shields of the size of the postorbitals, and but slightly larger than the scales. Cleft of mouth horizontal. Upper labials 9; the 5 anterior ones higher, the 4th and 5th entering into the orbit. Lower labials 10; the 4 anterior ones larger than the rest, which, as in *W. plumbea*, are not conspicuous.

Body subcylindrical, deeper than broad; abdomen narrow. Tail short and thick, blunt posteriorly. Scales as in *W. plumbea*, only proportionally smaller.

Puget Sound, Or. 210. 34. 45. $15\frac{1}{4}$. $2\frac{1}{16}$. (on dep.) Expl. Exped.

GENUS **RENA**, BAIRD & GIRARD.

GEN. CHAR. Head slightly depressed and continuous with the body. Snout blunt and rounded, overlapping considerably the lower jaw. A large rostral plate. One nasal. A pair of fronto-nasals. One eye shield, or ocular. A pair of parietals. A pair of postparietals. Medial row of scales extending over the head to the rostral. Nostrils lateral, oblong, situated between the nasal and fronto-nasal. Eyes not conspicuous. Mouth inferior, semilunar.

1. Rena dulcis, B. & G.—Reddish brown above; reddish white beneath. Fifteen rows of scales. Body depressed. Eye shield separated by a small plate from the series representing the vertical.

Body slender, elongated, rather stouter posteriorly than anteriorly, depressed, broader than deep. Tail very short, subconical, bluntly terminated, about $\frac{1}{20}$ of the total length. Rostral rounded, tapering, separating the fronto-nasals for nearly their whole length. Fronto-nasals proportionally large, tapering upwards, and undulating. Nasal subtriangular, nostril situated on the middle of its upper margin, close to the fronto-nasal. Eye shield large, elevated, irregularly oblong, extending to the top of the head from the margin of the jaw. Parietal and postparietal similar, transversally elongated, the postparietal somewhat larger. Four shield-shaped scales in a longitudinal series between the postparietals, parietals, eyeshield, fronto-nasals on each sides, and the rostral in front, occupy the place of the vertical. On the crown, and just above the eye-shield, is a small semilunar plate, separating it from the series just described, and probably the homologue of the supraorbital. The margin of the upper jaw is formed in front by the rostral; on the sides next to the rostral by the nasal, behind which is a subquadrangular, obliquely elevated labial, limited above by the fronto-nasal, and posteriorly by the eye-shield, which enters likewise in the upper labial series. Posterior to the eye-shield is a subtriangular labial at the angle of the jaw, approximating above the parietal, and limited behind by the

postparietal and the beginning of the scales. Inferior labials four, similar to the scales under the throat.

The scales present a great uniformity throughout the whole length of the body; a little smaller beneath than above.

Between San Pedro and Camanche Springs, Tex.	length $7\frac{1}{2}$.	tail $\frac{4}{10}$.	Col. J. D. Graham.

2. Rena humilis, B. & G.—Uniform chestnut-brown, lighter beneath. Scales in 15 rows. Body cylindrical. The eye-shield in contact with the longitudinal series on top of the head.

Body very slender and cylindrical. Tail short, conical, tapering, not acute, $\frac{1}{15}$ of the total length. Head less depressed. Eyes and nostril more distinct than in the preceding species. No supraorbitals. Postparietals much smaller than the parietals. Scales on the abdomen larger than on the back.

Vallicecitas, Cal.	length 6.	tail 4.	Dr. John L. Le Conte.

APPENDIX A.

SPECIES EXAMINED, OF WHICH NO SPECIMENS ARE IN POSSESSION OF THE SMITHSONIAN INSTITUTION.

Crotalus oregonus, HOLBR.—Grayish ash above, with narrow lighter lines decussating, so as to form dorsal and lateral rhomboids, with the angles all sharp and well defined, and their margins within the light lines, black. Beneath black. The dark postocular vitta passes above the labials without coming into the edge of the mouth. A light line across the head through the middle of the superciliaries.

SYN. *Crotalus oregonus*, HOLBR. N. Amer. Herp. III, 1842, 21. Pl. iii.

The only known specimen of this strongly marked species, and the same as that upon which Dr. Holbrook based his description, is too much shrivelled to admit of accurate description. In its general features it has a close resemblance to *C. adamanteus*, like it, having the back crossed by decussating light lines, enclosing transversely elongated rhomboids, with all the angles sharp and well defined. Of these rhomboids there are about 32 from head to anus.

The general color is grayish ash, the decussating lines being of a lighter tint of the same. Along the margins of the lozenges, and just within the light lines, is a black border. Scutellæ black, with ash-colored margins, the width of the ash-color diminishing from the head to the tail. There is a narrow, well-defined line across the head, just above the middle of the eye, which then appears to be continuous along the edge of the superciliaries to the angle of the jaw. A second white line starts between the nostril and the eye, and, passing back under the eye, strikes the edge of the mouth at the

7th labial, and extends along to the angle of the mouth: the ends of the anterior lines on opposite sides scarcely appear to meet on the top of the head. The vitta between these two light lines is dark ash, margined with black, and passes back above the labials to the angle of the mouth. The space in front of the second line is black, except a short narrow line produced along the labials anteriorly as a branch of the line in front of the eye. Edges of the nostril light.

The animal is quite young, there being but a single button.

An important feature of distinction from *C. adamanteus* is seen in the fact that the dark line on the side of the head passes above the labials to the angle of the mouth, instead of passing very directly down to the edge of the mouth, considerably anterior to the angle. The sharpness and close approximation of the rhomboids distinguish it from the other Western species. The head is much longer in proportion than in *C. lucifer*.

From the collection of the Academy of Natural Sciences of Philadelphia.

Columbia River. 177. 22. — 12½. 1¾. Thomas Nuttall.

Eutainia concinna, B. & G.—Dorsal rows of scales 21, all carinated. Black, with a dorsal light stripe, and the usual lateral stripes replaced by a series of distinct salmon-colored spots.

SYN. *Tropidonotus concinnus*, HALLOW. Proc. Acad. Nat. Sc. Philad. VI, 1852, 182.

Head small; body rather stout. Outer row of scales higher and larger than the rest, which are nearly equal. Above intense black, with a dorsal greenish white line one and two half-scales wide, and extending from head to tip of tail. On each side is a series of vertically elongated distinct spots of a reddish salmon-color, and 75 in number, between the head and anus. They occur on the 2d to the 6th rows of scales, and are half a scale long, the same color being visible on the adjoining skin. The dark intervals are one scale longer than the spots themselves. Beneath greenish black, tinged with white anteriorly. Whole head reddish yellow, tinged above with brown.

A near relative of our *Eutainia Pickeringii*. Belonging to the Academy of Natural Sciences.

Oregon. ♀ 163. 85. 21. 26. 7½. Dr. B. F. Shumard.

Nerodia niger, B. & G.—Head ellipsoid, anteriorly blunt, flattened above. Vertical plate very long, subhexagonal, slightly concave on the sides. Three postorbitals. Loral and nasals proportionally large. Dorsal scales in 23 rows. Color nearly uniform dark-brown on the back, maculated on the flanks and abdomen.

SYN. *Tropidonotus niger*, HOLBR. N. Amer. Herp. IV, 1842, 37. Pl. ix. Water Adder.

Body more slender, and head larger than in *N. sipedon*, though provided with 23 rows of scales, all of which are carinated. The scales of the outer row, however, are very large, proportionally more so than in *N. sipedon*, the nearest relative of this species. The prefrontals are triangular. The vertical plate is more elongated than in *N. sipedon*, whilst the occipitals are smaller. The nasals and loral are also larger, as are the labials, though their number is the same in both species. The prefrontals are triangular.

Ground-color chestnut-brown, with the scales streaked with black on the dorsal region, whilst the flanks are mottled, so as to appear darker. The head beneath, and the middle of the abdomen on the anterior portion of the body are yellowish. The sides of the abdomen, and posterior portion of body and tail, are densely maculated with black, almost entirely black beneath the tail.

From the Cabinet of the Academy of Natural Sciences.

Massachusetts. 141+1. 66. 23. 28½. 6½. Dr. D. H. Storer.

Nerodia rhombifer, B. & G.—Vertical plate elongated, narrow, sides nearly parallel. Dorsal scales 27; scales all carinated. Postorbitals two on one side, three on the other. Labials 8, 6th highest. A dorsal series and a lateral on each side of quadrate blotches; the alternating blotches of opposite sides connected across the back by dark lines passing into the dorsal series.

SYN. *Tropidonotus rhombifer*, HALLOW. Proc. Acad. Nat. Sc. Philad. VI, 1852, 177.

Ground-color light brown, or when the epidermis is removed, bluish ash. The dorsal dark spots are 50 in number from the head to the tip of the tail, the 35th opposite the anus. The lateral bars alternate with the preceding: they extend between the edges of the

abdomen and the 9th or 10th rows of scales, and are about one and a half scales long, separated by intervals of 2½ or 3 scales. The dark bars crossing the back obliquely, and connecting the alternating bars of opposite sides by their decussation and slight confluence, form the dorsal series of blotches. These lines are about half the width of the vertical bars, appearing like their bifurcations. They divide the back into a succession of transversely elongated hexagons of the ground-color. The dark markings are confined to the skin and the basal halves of the scales, the tips of these in all cases being of the ground-color. Beneath yellowish white, blotched along each side with darker.

Collected by Dr. S. W. Woodhouse, on the Arkansas river and its tributaries, near the northern boundary of the Creek nation, and in possession of the Topographical Bureau.

Arkansas River. 141+1. 70. 27. — — Dr. S. W. Woodhouse.

Nerodia transversa, B. & G.

SYN. *Tropidonotus transversus*, HALLOW. Proc. Acad. Nat. Sc. Philad. VI, 1852, 177.

Owing to the imperfect condition of the specimen upon which this species was founded, it has been impossible to determine its true affinities (except the generic), although strongly suspecting it to be the same, or at least very similar to *N. Woodhousii*, B. & G. If they be the same, the name of Dr. Hallowell will of course have priority, although neither the description nor the present condition of the specimen afford conclusive proof on this point. Dr. Hallowell's description is as follows:—"Head large, swollen at the temples, convex posteriorly, flattened between the orbits, depressed in front; a series of subquadrate dark-colored blotches, thirty-six or thirty-seven in number, along the back; a transverse row of oblong bars along the sides, their upper margins alternating with the inferior margins of the dorsal blotches; scales strongly carinated, 23 rows; abdominal scutellæ 144; subcaudal 78.

"*Dimensions.* Length of head 12 lines; greatest breadth 7; length of body 1 ft. (Fr.) 5 inches, 7 lines; length of tail 6 inches; total length 2 ft.

"*Habitat.* Creek boundary, found near the banks of the Arkansas and its tributaries."

Topographical Bureau.

Masticophis flagelliformis, B. & G.

A young individual in the cabinet of the Academy of Natural Sciences of Philadelphia, and labelled "*Coluber reticularis*, DAUD.," present the following characters, after long preservation in alcohol:—Above white, with a series of transverse dark bars across the back, extending from head to tail, about two scales long, and crossing from one side of the abdomen to the other. There is a faint indication of darker lateral lines extending through the centres of the lateral rows of scales. Beneath white, with two series of brown dotted lines extending from the chin for about one-fourth of the length. Plates on the top of the head yellowish, with darker margins.

South Carolina. — — 17. 19. 4¾. Acad. Nat. Sc.

APPENDIX B.

Species described by authors, but of which no specimens could be obtained.

1. Toxicophis atrofuscus, Troost.—Body above dusky, with light rhomboidal dorsal blotches of smoky gray, disappearing entirely near the tail, which is black.

Syn. *Toxicophis atrofuscus*, Troost. Ann. Lyc. Nat. Hist. N. Y. III, 1836, 190.
Acontias atrofuscus, Troost. ibid 180.
Trigonocephalus atrofuscus, Holbr. N. Amer. Herp. III, 1842, 43. Pl. ix.

"Upper part of the head dark-brown, bordered with gray, which becomes lighter behind the eyes, with a dark longitudinal spot reaching from the orbit to the tympanal bones. Upper lip white, terminating near the tip in gray. Body dusky, variegated with brown spots of smoke-gray; broadest on the back, and disappear on the tail, which is black. Throat marked with black and white, the latter color predominating; belly irregularly spotted with black and white, darkest towards the tail, and in all parts the white is minutely dotted with black."—Holbrook.

Tennessee. 133. 25+18. — 25. $3\frac{2}{5}$. Dr. G. Troost.

The species probably belongs really to the genus *Agkistrodon*, Beauv.

2. Coluber testaceus, Say.—"Body above pale sanguineous or testaceous; beneath sanguineous, immaculate."—Say.

Syn. *Coluber testaceus*, Say in *Long's* Exped. Rocky Mts. II, 1823, 48.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 348; and Med. & Phys. Res. 1835, 113.—Holbr. N. Amer. Herp. III, 1842, 63. Pl. xiii.

"Head subovate, elongated, the snout produced slightly and rounded. The form of the head, as well as the plates that cover it, and the disposition of the eyes and nostrils, appear in the preserved specimen to be precisely similar to those of *Coluber constrictor*. The body is long and slender, and is covered with large, smooth hexagonal scales above, and with broad plates below. The tail is long and slender. The whole upper surface of the animal is pale brick-dust color, the abdomen and below brighter red."—Holbr.

Rocky Mts.	198. 80. —	62. —		Thos. Say.

The figure represents the postabdominal scutella as divided. The species perhaps belongs to the genus *Masticophis*, more dorsal rows being represented than probably belong to it. It may prove to be *Masticophis flavigularis*, B. & G.

3. Coluber Sayi, Schl. (non Holbr.)—General color reddish orange, with a dorsal series of transverse blotches, forming bands towards the posterior region of the body. Flanks mottled or maculated.

Syn. *Coluber Sayi*, Schl. Ess. Phys. Serp. Part. descr. 1837, 157.

Coluber melanoleucus var. Say.—Harl. Journ. Acad. Nat. Sc. Philad. V, 1827, 360; and Med. & Phys. Res. 1835, 123.

"This species is beyond all dispute one of the handsomest of the genus (*Coluber*), and as well characterized by the shape of its snout and the plates of its surface as by the beautiful reddish yellow tint predominant over all the regions of the body. The back, however, is of a deeper chestnut-brown, in the midst of which the ground-color appears in the shape of numerous transverse and oval blotches: these two tints constitute towards the posterior region broad and alternating bands, extending to the inferior surface. The anterior region is deeper in color, spotted or maculated with black like the abdomen, or else exhibiting large patches of this same tint.

"The head is distinct from the neck, and covered with plates, the vertical of which is a spherical triangle almost equilateral; the occipitals are noticeable for their small size; the labials are large, and margined with black, but are not to be distinguished from the scales of the body, which are lanceolated, provided with a carina, and disposed in 25 rows.

"There are three postorbital plates and but one anteorbital, preceded by a very small loral. The snout is conical, and terminated

by a plate, which has the shape of a prominent nose, on each side of which are the nasals. Our specimen has two pairs of postfrontals disposed on a single transverse row.

"The bones which constitute the skull are stouter than in the other species of *Coluber*. The tympanum is longer, and the nasals elongated. The intermaxillary is very depressed. The teeth are all of the same length."—Schlegel.

The specimen described was brought from the Rocky Mountains by Mr. Say, and presented to M. Schlegel by Charles L. Bonaparte.

Missouri. 221. 55. 25. — about 4 feet.

The species here referred to belongs undoubtedly to the genus *Pituophis*. The general system of coloration, the peculiar shape and structure of the snout, and the presence of two pairs of postfrontal plates, are characters which this genus alone possesses in the manner just described.

As to Say's variety of *Coluber melanoleucus*, as given by Harlan, it is introduced into the synonymy with some doubt.

4. Coluber vertebralis, Blainv.—"Reddish yellow or pale red, marbled with deep brown, forming a dorsal united series in the shape of a succession of sections of fish vertebræ, becoming isolated and more apart towards the posterior region."

Syn. *Coluber vertebralis*, Blainv. Nouv. Ann. Mus. d'Hist. Nat. III, 1834, 61. Pl. xxvii. figs. 2, 2 a, and 2 b.

"Body elongated and slender anteriorly; head small and comparatively distinct; snout pointed; tail short, conical, and pointed. Nostrils lateral, small, circular, between the two nasal plates. Eyes large, lateral, almost entirely surrounded with the orbital plates. Cephalic plates: two prefrontals and two postfrontals; two lorals superposed. Two anteorbitals and three postorbitals. Abdominal scutellæ 245; subcaudal 64. Scales rather small, lozenge-shaped, smooth, imbricated."

California. — — — — — M. Botta.

This species is not without a certain resemblance to *Pituophis*. The chained dorsal blotches, the acute head, prominent snout, and presence of two lorals, the upper one resembling in shape and posi-

tion an exterior pair of postfrontals, are the characters which lead us to this belief. Its generic affinities, however, cannot be determined without specimens in hand. The smooth scales would militate against the supposition of its being a *Pituophis*.

5. **Coluber (Ophis) Californiæ**, Blainv.—"Yellow, lighter beneath, darker above, with six longitudinal bands more or less effaced, and more or less anastomosed, of a black color, the upper ones broader and often united."

Syn. *Coluber (Ophis) Californiæ*, Blainv. Ann. Mus. d'Hist. Nat. III, 1834, 60. Pl. xxvii. figs. 1, 1 a, 1 b.

"Body of ordinary form and medium length; head proportionally large, depressed; snout short and obtuse. Tail rather short, conical, and pointed. Nostrils lateral, oval, between the two nasal plates, contiguous to the frontals. Eyes of medium size, lateral. Cephalic plates. Two prefrontals and two postfrontals; one loral; one anteorbital and two postorbitals. Scales rather small, lozenge-shaped, imbricated, and perfectly smooth."

California. — — — — — M. Botta.

6. **Coluber (Zacholus) zonatus**, Blainv.—"Reddish white, entirely annulated with deep black, with two half-rings of the same color on the head."

Syn. *Coluber (Zacholus) zonatus*, Blainv. Nouv. Ann. Mus. d'Hist. Nat. III, 1834, 61.

"Body cylindrical, back depressed, subcarinated, suddenly attenuated posteriorly, and but slightly anteriorly. Head small, tetragonal, with an obtuse and thick snout; tail short, small, and very much tapering, about $\frac{1}{7}$ of total length. Nostrils lateral, large, infundibuliform, in the midst of the two nasal plates. Eyes large and lateral. Mouth deeply cleft; anus very far back. Cephalic plates: two prefrontals and two postfrontals; one loral, very small; one anteorbital and two postorbitals, very small. Scales rather large, rhomboidal, subimbricated, increasing in size from the back towards the sides, subconvex and perfectly smooth."

California. — — — — — M. Botta.

7. Coluber planiceps, Blainv.—"Uniform reddish above, of a soiled white beneath, with a black patch on the occiput and the beginning of the neck."

Syn. *Coluber planiceps*, Blainv. Nouv. Ann. Mus. Hist. Nat. III, 1834, 62. Pl. xxvii, figs. 3, 3 a, 3 b.

"Body slender, rather elongated, cylindrical; head small, depressed, but little distinct; snout short and elliptical; tail rather long, slender, and very much tapering, ¼ of the total length. Nostrils lateral, very small, situated in the middle of the nasal, which is elongated and single. Eyes of medium size. Mouth broad, considerably cleft; anus far back. Cephalic plates: two prefrontals and two postfrontals. No loral. One anterior and one postorbital. Abdominal scutellæ 134, beginning at some distance from the head. Subcaudal 56. Scales broad, convex, very smooth, opalescent, obliquely imbricated."

California. — — — — — M. Botta.

Genus **CHARINA,** Gray.

Gen. Char. Resembles *Wenona* in general shape and appearance, and bears with it many affinities in structure. There are two lorals instead of one; three anteorbitals instead of one; three superciliaries instead of one; and the subcaudal scutellæ much narrower, and more elongated transversely. The comparison of specimens will no doubt show other generic differences inappreciable by the descriptions.

Syn. *Charina*, Gray, Catal. of Snakes in Brit. Mus. 1849, 113.

8. Charina Bottæ, Gray.—Body cylindrical, blunt at each end; pale yellow; back and tail darker.

Syn. *Charina Bottæ*, Gray, Catal. of Snakes in Brit. Mus. 1849, 113.
Tortrix Bottæ, Blainv. Nouv. Ann. Mus. Hist. Nat. III, 1834, 57. Pl. xxvi, figs. 1, 1 a, 1 b.

Genus **OPHTHALMIDION**, Dum. & Bibr.

Gen. Char. Head more or less depressed, covered with plates; rostral plate recurved under the snout, the tip of which is rounded, and extending to the upper part of the head in the shape of an oval cap. An anterior frontal plate. A frontal proper. A pair of supraoculars. A pair of parietals; no interparietals, or one only. A pair of nasals. A pair of fronto-nasals. A pair of oculars. A pair of preoculars. Nostrils hemidiscoid, opening under the snout, one to the right, the other to the left, between the nasal and fronto-nasal. Eyes lateral, more or less distinct.

Syn. *Ophthalmidion*, Dum. & Bibr. Erp. Gen. VI, 1844, 262; and Catal. Rept. Mus. d'Hist. Nat. II, 1852, 201.

9. Ophthalmidion longissimum, Dum. & Bibr.—Tail double the length of the width of the head, cylindrical, straight, rounded at the tip, and provided with a small spine. Nasal plates in the shape of little subrectangular bands, placed longitudinally on each side at the inferior part of the rostral. Oculars in vertical subhexagonal bands, less developed than the preoculars, and showing the eyes but slightly through. Head yellowish, the whole body of a grayish tint.

Syn. *Ophthalmidion longissimum*, Dum. & Bibr. Erp. Gen. VI, 1844, 263; and Catal. Rept. Mus. Hist. Nat. II, 1852, 201.

N. America. Collected by Comte de Castelnau. Florida. ? ?

The following species given by Schlegel in his *Essai* as North American, cannot be admitted into our fauna without further evidence.

Calamaria melanocephala.....................Surinam & Philada
Lycodon clelia...Philada
Herpetodryas margaritiferus..........................New Orleans.
Herpetodryas cursor..New York.
Dryophis Catesboei.....................................Southern States.
Dipsas annulata...Delta of Miss.
Homalopsis carinicauda.......................................New York.
Homalopsis plicatilis, Var...............................New Orleans.

APPENDIX C.

SPECIES COLLECTED BY JOHN H. CLARK AND ARTHUR SCHOTT, ON THE U. S. AND MEXICAN BOUNDARY SURVEY, UNDER MAJ. WM. H. EMORY, U. S. A., AND RECEIVED TOO LATE FOR INSERTION IN THEIR PROPER PLACES.

1. Crotalus atrox, B. & G .... Page 5

Pecos, Tex.	— — 15.	35. $2\frac{6}{8}$.	John H. Clark.
Eagle Pass, Tex.	— — 15.	29. $2\frac{1}{2}$.	Arthur Schott.

2. Toxicophis pugnax, B. & G .... Page 20

Eagle Pass, Tex.	138. 43. 25.	28. $4\frac{1}{2}$.	Arthur Schott.

3. Elaps tenere, B. & G .... Page 22

The ground-color of the present specimen is red, the same as in *Elaps fulvius;* the fact of its being fawn-colored in the specimen described above must be attributed to the action of the preserving fluid. The specimens here referred to are of a greater size, but exhibit all the other characters by which we have distinguished this species from *Elaps fulvius.*

San Felipe, Tex.	— — —	— —	John H. Clark.
Eagle Pass, Tex.	— — —	— —	Arthur Schott.

4. Eutainia Marciana, B. & G .... Page 36

Eagle Pass, Tex.	— — —	— —	Arthur Schott.

5. Heterodon nasicus, B. & G. ....Page 61

Specimens of this species vary in the number of small postrostral plates. In some there are only three or four, in others a larger number. Sometimes, instead of a single series of median dorsal spots, there are two, in close contact, and more or less confluent. The narrow light line across the middle of the superciliaries and the high labials are still highly characteristic.

Pecos, Tex.	130+1. 40. 23.	$14\frac{1}{2}$. $2\frac{5}{8}$.	John H. Clark.
"	141+1. 29. 23.	$20\frac{1}{2}$. $2\frac{3}{8}$.	"
"	141+1. 37. 23.	$23\frac{1}{2}$. $3\frac{1}{4}$.	"
Eagle Pass, Tex.	144+1. 38. 23.	$26\frac{1}{2}$. $3\frac{1}{2}$.	Arthur Schott.

6. Pituophis bellona, B. & G. ....Page 66

Presidio del Norte, Mex.	243. 51. 32.	$51\frac{1}{2}$. 6.	John H. Clark.

7. Scotophis Emoryi, B. & G.—Head rather narrow; vertical plate elongated. Eye large. Median six or eight scales only carinated; very slightly. Dorsal rows 29. Above ash-gray, with a dorsal series of transverse brown blotches, on each side of which are two others of smaller size; indistinct traces of a third. A frontal brown vitta passing back through the eye, and crossing the angle of the mouth on to the side of the neck.

Plates and shape of head much as in *S. guttatus*. Vertical plate more elongated than in the species of allied color, being decidedly longer than broad. Head rather narrow. Eye larger than in *S. guttatus*, its centre a little posterior to the junction of the 4th and 5th labials. Postorbitals resting on the 5th labial, as in the other species. Anteorbital large. Loral elongated, acute angled behind. Upper labials 8, 6th and 7th largest; lower 11, 6th largest. Dorsal rows of scales 29, central five or six only carinated, and those only slightly: exterior row largest, rest nearly equal. Ground-color grayish ash. A series of olivaceous brown transverse quadrate blotches along the back, 70 in number, the 50th opposite the anus. These are ten or twelve scales broad, two to three long, and separated by intervals of one to two scales. They are narrowly margined with black. On each side of the dorsal series, and alternating with it, is a series of smaller, nearly circular, but similarly constituted blotches extending between the 3d, and 7th or 8th rows: below this,

and on the 2d and 3d rows, is a still smaller and quite indistinct third series, and occasionally traces of a fourth on the 1st and 2d. The ground-color or space between the blotches is grayish ash; each scale minutely mottled with dark-brown or black; the extreme border generally pure ash, especially on the sides. Beneath yellowish white, with rather indistinct blotches of brownish ash, thickest behind.

Head grayish ash, with a somewhat curved broad brown vitta on the back part of the postfrontals, which, involving the commissure of the anteorbital and superciliary, passes back through the eye, and crossing the angle of the mouth on the adjacent halves of the ultimate and penultimate labials, extends into the blotches on the sides of the neck. A second nearly effaced bar crosses the anterior frontals, leaving an ash-colored band half the width of the first-mentioned bar. The anterior dorsal blotch is replaced by two elongated ones running up on the head to the centre of the occipitals, parallel with the postocular vitta, with an ash-colored stripe between the two, which extends from the superciliary backwards on the sides of the neck. As in the other brown marks, these stripes are margined by black. The adjacent edges of the 4th and 5th labials are brown. This is the only species except *S. guttatus*, in which the postocular vitta crosses the angle of the mouth, and passes down the side of the neck. There is scarcely any indication of elongation in the lateral spots except anteriorly.

This species differs from *S. vulpinus* in the gray color, much larger eye, longer head, narrower vertical, &c.; from *S. lætus* in much the same points as well as in having the dorsal spots transverse not longitudinal; from *S. Lindheimeri* in lighter color, and absence of white margins to the basal ends of the dorsal scales.

Howard Springs, Tex. 217+1. 72. 29. 41¼. 7. J. H. Clark.

8. Georgia obsoleta, B. & G.—Postorbitals resting on the fifth labials, not on the 4th, as in *Georgia Couperi*. Black above, beneath slate-color; anteriorly with the bases of the scutellæ red.

SYN. *Coluber obsoletus*, SAY in *Long's* Exped. Rocky Mts., I, 1823, 140.—HARL. Journ. Acad. Nat. Sc. Philad. V, 1827, 347; and Med. & Phys. Res. 1835, 112.—HOLBR. N. Amer. Herp. III, 1842, 61. Pl. xii.

Upper labials 8; 7th and 8th largest; postorbitals supported by the 5th; 6th labial small, triangular, but still separating the 5th and

7th, which do not meet above it. Lower labials 9; 4th and 5th largest. Two rows of temporal shields. Two lorals in one specimen, one in another. General color above deep black; some of the scales having dashes of reddish white at their bases, scarcely indicating blotches as in *Scotophis:* the same color is sometimes shown on the skin. Beneath slate-black. The color is uniform on the posterior half: the bases of the scutellæ then begin to exhibit more or less of pale reddish white, which tint increases in extent and intensity anteriorly until towards the head the slate-color is only seen along their edges, the tint there being a dark salmon-color. The posterior margins of the upper and lower labials, as well as all the plates on the sides of the neck and beneath, are edged with well-defined black. Sides of the head reddish brown, margined as above.

Eagle Pass, Tex.	193. 60. 17.	$45\frac{3}{4}$. $7\frac{3}{4}$.	Arthur Schott.
"	193. 56. 17.	$48\frac{1}{2}$. $9\frac{3}{4}$.	"

9. Ophibolus Sayi, B. & G. .... Page 84

Variety with transverse penultimate bands.

Eagle Pass, Tex.	210. 59. 23.	$37\frac{6}{8}$. $5\frac{2}{8}$.	Arthur Schott.

10. Masticophis flavigularis, B. & G. .... Page 99

Mr. Clark mentions having seen specimens of this species on the upper Rio Grande, with a decided tinge of red. It would not surprise us, therefore, to find it the same with *Coluber testaceus*, Say—a point of much interest, as this is the only one of Say's Western species which we have not identified as clearly distinct.

Presidio del Norte, Mex.	200+1. 167. 17.	56. $15\frac{1}{8}$.	John H. Clark.

11. Masticophis ornatus, B. & G. .... Page 102

A highly marked specimen, differing somewhat from those already described. Very dark purple on the back, lighter on the sides between the light lines. A narrow yellow line along the contiguous edges of the abdomen and outer dorsal rows. The 4th row of scales with the adjacent edges of the 3d and 5th, are yellowish white, with a well-defined black line through the centre of the former. Down the centre of all the rows as well as the fourth, is a black line, most intense on the 1st and 3d rows. At successive intervals along

the back, are seen broad transverse light bands, produced by the obliteration of the black line in the 4th row, and by all the dorsal scales between the light lines being yellowish white, with more or less of purplish black towards the tips. There are about eight of these dorsal marks on the anterior three-fifths of the body, the first being indicated by a light bar on the nape.

Howard Springs, Tex. 206+1. — 15. $61\frac{3}{8}$. $17\frac{5}{8}$. J. H. Clark.

12. Masticophis Schotti, B. & G.—Greenish brown, with two narrow white lines on each side, becoming obsolete at about three-fifths of the length from the head. Scales on the back yellow at the base. Sides of the neck in front red. Dorsal scales in 15 rows.

This species presents quite a close relationship to *M. tæniatus*, although sufficiently different in its distribution of color. The general tint above is a dark greenish olive. On each side are two well-defined narrow yellowish white lines: the first along the junction of the outer dorsal row and the abdominal scutellæ, involving only the adjacent angles; the second similarly constituted in relation to the 3d and 4th rows (not running through the centres of the scales). The portion of the 3d and 4th rows not involved by the upper white line is black, as is also a narrow margin above the lower white line, of the same diameter with it. The upper angles of the scales in the first row, and the whole of those of the second row, are of a lighter olive than the back. All the scales on the back between the upper yellow lines of opposite sides are margined with yellow along their basal edges, only evident on separating the scales. Anteriorly is a short yellow line along the junction of the 2d and 3d rows of scales, extending to about the 25th abdominal scutella.

Color beneath dull yellow, with the greater part of the scutellæ closely and minutely blotched with greenish slate. Anteriorly the proportion of yellow is much greater, and near the head the blotching is in two series, as in the rest of the genus. The tail also is nearly unspotted yellowish, except anteriorly. On the external fourth of the abdominal scutellæ the blotching is more confluent, forming a well-defined margin to the lower yellow line. Anteriorly the side of the abdomen is of a dull red. The upper jaw is yellowish white, excepting the lower edges along the 1st to the 6th labials, which are black. Orbitals, loral, and nasals with a yellow central spot.

The lateral stripes become obsolete at about $\frac{3}{5}$ of the length from the head, so that the body posteriorly is nearly unicolor above. Upper labials 8, 7th longest; lower 9, 5th largest.

Eagle Pass, Tex. 201+1. 138. 15. 54½. 17¾. Arthur Schott.

13. Salvadora Grahamiæ, B. & G. ....Page 104

This specimen has but two anteorbitals, the upper very large; in other respects it is as previously described. The under parts appear to have been of a delicate reddish salmon-color.

Presidio del Norte, Mex. 189+1. 100. 17. 28¾. 7¾. John H. Clark.

14. Leptophis majalis, B. & G. ....Page 127

Eagle Pass, Tex. 162+1. 127. 17. 28. 16⅞. Arthur Schott.

15. Diadophis regalis, B. & G. ....Page 115

Eagle Springs, Tex. 229+1. 56. 17. 25¾. 4. John H. Clark.

16. Rhinocheilus Lecontei, B. & G. ....Page 120

Pecos, Tex. 191. 56. 23. 26⅞. 4⅛. John H. Clark.

17. Tantilla gracilis, B. & G. ....Page 132

Eagle Pass, Tex. 133. 44. 15. 7¾. 1⅝. Arthur Schott.

APPENDIX D.

Index of Sources from which the Specimens have been received.

APPENDIX E.

Index of States and Territories from which Specimens have been received.

ALPHABETICAL INDEX.

1.—VERNACULAR NAMES.*

* Such vernacular names as have been omitted in the body of the catalogue are here given with their systematic titles placed within parentheses.

M.

P.

R.

S.

T.

U.

V.

W.

2.—SYSTEMATIC NAMES.

D.

E.

L.

M.

N.

O.

P.

THE END.

SMITHSONIAN MISCELLANEOUS COLLECTIONS.

CHECK LISTS

OF THE

SHELLS OF NORTH AMERICA.

PREPARED FOR THE SMITHSONIAN INSTITUTION,

BY

**ISAAC LEA, P. P. CARPENTER, WM. STIMPSON,
W. G. BINNEY, AND TEMPLE PRIME.**

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SMITHSONIAN INSTITUTION.
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INTRODUCTION.

THE following lists of the described species of North American shells have been prepared at the request of this Institution, by several accomplished conchologists, for the purpose of labelling the specimens in the Smithsonian collection.

Applications having been made for copies of the lists, it has been though that their publication would be generally useful, in facilitating the pre paration of catalogues, the labelling of collections, conducting exchanges, checking off faunas of particular regions, etc.

The series of lists is complete with the exception of that of the marine fauna of the West India Province, including the shores of Florida, the Gulf coast, the West Indies, etc. On account of the great extent of this province, and the uncertainty in relation to many of its species, together with their imperfect representation in American conchological collections, it has been thought expedient to omit for the present a list of its shells. As soon as such a list can be properly prepared, it will be added to the series.

In accordance with the views of a majority of the compilers of the lists, the authority given for each name refers to the original describer of the species, and not to the one who first published the name, both generic and specific, as here printed.

It will be readily understood that the Smithsonian Institution cannot vouch for the accuracy of the names of the lists or for their completeness, and that all responsibility in reference to these points rests with the several authors.

JOSEPH HENRY,
Secretary S. I.

SMITHSONIAN INSTITUTION,
May, 1860.

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CHECK LIST

OF THE

SHELLS OF NORTH AMERICA.

WEST COAST:

OREGONIAN AND CALIFORNIAN PROVINCE.

BY

P. P. CARPENTER.

THIS list is condensed from that presented in the "Report to the British Association," 1856, pp. 298 *et seq.* Species are omitted which have since been discovered to be synonyms, or which rest on doubtful authority as occurring in this zoological province; which is known to extend from Puget Sound to San Diego. Stragglers from other districts are omitted; as also the species peculiar to the peninsula of Lower California.

The generic names alone are given of undescribed species in the Smithsonian collection, or of species not yet satisfactorily identified.

PALLIOBRANCHIATA.

Discinidæ.

1. Discina Evansii, *Dav.*

Terebratulidæ.

2. Waldheimia californica, *Koch.*
3. Terebratella caurina, *Gld.*
4. Terebratella pulvinata, *Gld.*

LAMELLIBRANCHIATA.

Pholadidæ.

5. Teredo
6. Zirphæa ?crispata, *Linn.*
7. Pholadidea ovoidea, *Gld.*
8. Pholadidea penita, *Conr.*
9. Parapholas californica, *Conr.*

Saxicavidæ.

10. Saxicava pholadis, *Lam.*

Myidæ.

11. Panopæa generosa, *Gld.*
12. Mya præcisa, *Gld.*
13. Platyodon cancellata, *Conr.*
14. Cryptomya californica, *Conr.*
15. Tresus capax, *Gld.*
16. Schizothoerus Nuttallii, *Conr.*

Corbulidæ.

17. Neæra
18. Sphænia

Anatinidæ.

19. Thracia curta, *Conr.*
20. Lyonsia californica, *Conr.*
21. Mytilimeria Nuttallii, *Conr.*
22. Periploma argentaria, *Conr.*
23. Pandora punctata, *Conr.*
24. Pandora

Solenidæ.

25. Solen sicarius, *Gld.*

Solecurtidæ.

26. Machæra lucida, *Conr.*
27. Machæra patula, *Port.*
28. Solecurtus californianus, *Conr.*
29. Solecurtus subteres, *Conr.*

Tellinidæ.

30. Sanguinolaria Nuttallii, *Conr.*
31. Sanguinolaria rubroradiata, *C*
32. Psammobia pacifica, *Conr.*
33. Tellina bodegensis, *Hds.*
34. Tellina
35. Tellina

36. Tellina
37. Tellina
38. Macoma edulis, *Nutt.*
39. Macoma inconspicua, *B. & Sby.*
40. Macoma nasuta, *Conr.*
41. Macoma secta, *Conr.*
42. Scrobicularia alta, *Conr.*
43. Strigilla carnaria, *Linn.*
44. Semele decisa, *Conr.*
45. Semele rubrolineata, *Conr.*
46. Cumingia californica, *Conr.*

Donacidæ.

47. Donax californicus, *Conr.*
48. Donax flexuosus, *Gld.*
49. Arcopagia vicina, *C. B. Ad.*

Mactridæ.

50. Mactra californica, *Conr.*
51. Mactra falcata, *Gld.*
52. Mactra planulata, *Conr.*

Veneridæ.

53. Trigona crassatelloides, *Conr.*
54. ?Trigona tantilla, *Gld.*
55. Dione callosa, *Conr.*
56. Venus californiensis, *Sby.*
57. Venus dispar.
58. Venus excavata, *Cpr.*
59. Venus fluctifraga, *Sby.*
60. Venus Nuttallii, *Conr.*
61. Venus
62. Tapes gracilis, *Gld.*
63. Tapes Petitii, *Desh.*
64. Tapes rigida, *Gld.*
65. Tapes staminea, *Conr.*

Petricolidæ.

66. Petricola californica, *Conr.*
67. Rupellaria lamellifera, *Conr.*
68. Saxidomus aratus, *Gld.*
69. Saxidomus Nuttallii, *Conr.*

Astartidæ.

70. Astarte
71. Trapezium californicum, *Conr.*
72. Cardita ventricosa, *Gld.*

Chamidæ.

73. Chama exogyra, *Conr.*
74. Chama pellucida, *Rve.*

Cardiadæ.

75. Cardium californiense, *Desh.*
76. Cardium (*like* grœnlandicum).
77. Cardium luteolabrum, *Gld.*
78. Cardium Nuttalli, *Conr.*
79. Cardium quadragenarium, *Con.*
80. Cardium substriatum, *Conr.*

Lucinidæ.

81. Lucina bella, *Conr.*
82. Lucina californica, *Conr.*
83. Lucina Nuttallii, *Conr.*
84. Lucina
85. Cryptodon

Diplodontidæ.

86. Diplodonta orbella, *Gld.*

Kelliadæ.

87. Kellia Laperousii, *Desh.*
88. Kellia [rugifera].
89. Kellia suborbicularis, *Mont.*
90. Lasea
91. Montacuta

Mytilidæ.

92. Mytilus californianus, *Conr*
93. Mytilus edulis, *Linn.*
94. Mytilus glomeratus, *Gld.*
95. Septifer
96. Modiola capax, *Conr.*
97. Modiola elongata, *Swains.*
98. Modiola flabellata, *Gld.*
99. Modiola modiolus *Linn.*
100. Modiola nitens, *Cpr.*
101. Modiola recta, *Conr.*
102. Modiola
103. Crenella [*like* discrepans].
104. Lithophagus falcatus, *Gld.*
105. Lithophagus

Arcadæ.

106. Arca labiata, *Sby.*
107. Arca ?multicostata, *Sby.*
108. Byssoarca pernoides, *Cpr.*
109. Axinæa septentrionalis, *M.*

Nuculidæ.

110. Nucula cælata, *Hds.*
111. Nucula ?tenuis, *Mont.*
112. Leda ?caudata, *Mont.*
113. Leda
114. Yoldia
115. Yoldia

Pectinidæ.

116. Pecten Fabricii, *Phil.*
117. Pecten hericius, *Gld.*
118. Pecten (*like* Islandicus).
119. Pecten latiauratus, *Conr.*
120. Pecten ?nodosus, *Linn.*
121. Pecten purpuratus, *Lam.*
122. Pecten ?ventricosus, *Sby.*
123. Amusium caurinum, *Gld.*
124. Janeira florida, *Hds.*
125. Hinnites giganteus, *Gray.*

Ostræidæ.

126. Ostrea conchaphila, *Cpr.*
127. Ostrea [lurida].
128. Ostrea rufa, *Gld.*

Anomiadæ.

129. Placunanomia alope, *Gray.*

130. Placunanomia cepio, *Gray*.
131. Placunanomia macroschisma, [*Desh*.
132. Anomia lampe, *Gray*.

GASTEROPODA OPISTHOBRANCHIATA.

Bullidæ.

133. Bulla nebulosa, *Gld*.
134. Haminea vesicula, *Gld*.
135. Haminea virescens, *Sby*.
136. Haminea
137. Tornatina cerealis, *Gld*.
138. Tornatina culcitella, *Gld*.
139. Tornatina inculta, *Gld*.
140. Tornatina
141. Cylichna

GASTEROPODA PROSOBRANCHIATA.

CIRRIBRANCHIATA.

Dentaliadæ.

142. Dentalium
143. Dentalium

SCUTIBRANCHIATA.

Chitonidæ.

144. Callochiton interstinctus, *Gld*.
145. Lepidochiton Mertensii, *Midd*.
146. Lepidochiton scrobiculatus, *M*.
147. Tonicia lineata, *Wood*.
148. Mopalia Blainvillei, *Brod*.
149. Mopalia Hindsii, *Sby*.
150. Mopalia Simpsonii, *Gray*.
151. Mopalia vespertina, *Gld*.
152. Katherina tunicata, *Sby*.
153. Cryptochiton Stelleri, *Midd*.
154. (Chiton) acutus, *Cpr*.
155. (Chiton) californicus, *Nutt*.
156. (Chiton) dentiens, *Gld*.
157. (Chiton) Hartwegii, *Cpr*.
158. (Chiton) lignosus, *Gld*.
159. (Chiton) montereyensis, *C*.
160. Chiton muscosus, *Gld*.
161. (Chiton) Nuttalli, *Cpr*.
162. (Chiton) ornatus, *Nutt*.
163. (Chiton) regularis, *Cpr*.
164. Chiton scaber, *Rve*.
165. (Chiton) Wosnessenskii, *M*.

Patellidæ.

166. Patella toreuma, *Rve*.
167. Nacella depicta, *Hds*.
168. Nacella incessa, *Hds*.
169. Nacella instabilis, *Gld*.

Acmæidæ.

170. Acmæa Asmi, *Midd*.
171. Acmæa patina, *Esch*.
172. Acmæa pelta, *Esch*.
173. Acmæa persona, *Esch*.
174. Acmæa scabra, *Nutt*.
175. Acmæa spectrum, *Nutt*.
176. [Tecturella] grandis, *Gray*.
177. Scurria mitra, *Esch*.

Fissurellidæ.

178. Fissurella volcano, *Rve*.
179. Glyphis aspera, *Esch*.
180. Lucapina crenulata, *Sby*.
181. Puncturella cucullata, *Gld*.
182. Puncturella galeata, *Gld*.

Haliotidæ.

183. Haliotis californiensis, *Swains*.
184. Haliotis corrugata, *Gray*.
185. Haliotis Cracherodii, *Leach*.
186. Haliotis [*like* kamtschatkiana]
187. Haliotis rufescens, *Swains*.
188. Haliotis splendens, *Rve*.

Trochidæ.

189. Phasianella compta, *Gld*.
190. Pomaulax undosus, *Wood*.
191. Pachypoma diadematum, *Val*
192. Trochiscus Norrisii, *Sby*.
193. Ziziphinus annulatus, *Mart*.
194. Ziziphinus doliarius, *Chemn*.
195. Ziziphinus filosus, *Wood*.
196. Livona picoides, *Gld*.
197. Osilinus gallina, *Fbs*.
198. Osilinus
199. Omphalius aureotinctus, *Fbs*.
200. Omphalius brunneus, *A. Ad*.
201. Omphalius euryomphalus, *J*.
202. Omphalius fuscescens, *Phil*.
203. Omphalius mæstus, *Jonas*.
204. ?Omphalius marcidus, *Gld*.
205. Omphalius marginatus, *Nutt*.
206. Omphalius Pfeifferi, *Phil*.
207. Margarita callostoma, *A. Ad*.
208. Margarita pupilla, *Gld*.
209. Margarita
210. Margarita
211. Margarita
212. Margarita

PECTINIBRANCHIATA.

Calyptræidæ.

213. Crucibulum spinosum, *Sby*.
214. Galerus fastigiatus, *Gld*.
215. Crepidula aculeata, *Linn*.
216. Crepidula adunca, *Sby*.
217. Crepidula explanata, *Gld*.
218. Crepidula incurva, *Brod*.

219. Crepidula lingulata, *Gld.*
220. Crepidula nummaria, *Gld.*
221. Crepidula rugosa, *Nutt.*
222. Hipponyx antiquatus, *Linn.*
223. Hipponyx barbatus, *Sby.*
224. Hipponyx Grayanus, *Mke.*

Vermetidæ.

225. Aletus squamigerus, *Cpr.*
226. Spiroglyphus
227. Spiroglyphus

Turritellidæ.

228. Mesalia
229. Mesalia

Cerithiadæ.

230. Bittium filosum, *Gld.*
231. Bittium
232. Bittium
233. Cerithidea albonodosa, *Cpr.*
234. Cerithidea pullata, *Gld.*
235. Cerithidea sacrata, *Gld.*

Litorinidæ.

236. Litorina planaxis, *Phil.*
237. Litorina plena, *Gld.*
238. Litorina scutellata, *Gld.*
239. Litorina sitchana, *Phil.*
240. Lacuna carinata, *Gld.*
241. Lacuna unifasciata, *Cpr.*

Ovulidæ.

242. Radius variabilis, *Sby.*

Cypræidæ.

243. Luponia albuginosa, *Gray.*
244. Luponia spadicea, *Swains.*
245. Trivia californica, *Gray.*
246. Erato leucophæa, *Gld.*

Cancellariadæ.

247. Trichotropis cancellata, *Hds.*

Pleurotomidæ.

248. Drillia
249. Daphnella
250. Mangelia
251. Mangelia
252. Bela fidicula, *Gld.*
253. Bela

Conidæ.

254. Conus ravus, *Gld.*

Pyramidellidæ.

255. Odostomia gravida, *Gld.*
256. Odostomia
257. Parthenia
258. Chemnitzia [chocolata].
259. Chemnitzia tenuicula, *Gld.*
260. Chemnitzia torquata, *Gld.*

Eulimidæ.

261. Eulima

Scalariadæ.

262. Scalaria australis, *Phil.*
263. Scalaria [*like* ochotensis].
264. Scalaria

Naticidæ.

265. Natica ?clausa, *Brod. & Sby.*
266. Natica impervia, *Phil.*
267. Lunatia algida, *Gld.*
268. Lunatia caurina, *Gld.*
269. Lunatia Lewisii, *Gld.*
270. Neverita Recluziana, *Rve.*
271. Polinices perspicua, *Recl.*

Tritonidæ.

272. Argobuccinum oregonense, *Redf*

Ranellidæ.

273. Ranella californica, *Hds.*
274. Ranella triquetra, *Rve.*

Mitrinæ.

275. Mitra maura, *Nutt.*

Marginellidæ.

276. Marginella Jewettii, *Cpr.*

Olividæ.

277. Olivella biplicata, *Sby.*
278. Olivella rufofasciata, *Rve.*
279. Olivella

Purpuridæ.

280. Purpura decemcostata, *Midd.*
281. Purpura emarginata, *Desh.*
282. Purpura lactuca, *Esch.*
283. Purpura ostrina, *Gld.*
284. Monoceros engonatum, *Conr.*
285. Monoceros lapilloides, *Conr.*
286. Nitidella Gouldii, *Cpr.*
287. Nitidella
288. Truncaria
289. Cerastoma Belcheri, *Hds*
290. Cerastoma foliatum, *Esch.*

Buccinidæ.

291. Columbella californiana, *Gask*
292. Columbella carinata, *Hds.*
293. Columbella gausapata, *Gld.*
294. Columbella sta-barbarensis, *C.*
295. Buccinum corrugatum, *Rve.*
296. Nassa fossata, *Gld.*
297. Nassa mendica, *Gld.*

Muricidæ.

298. Chrysodomus antiquus, *Linn.*
299. Chrysodomus Middendorffii,
300. Chrysodomus [*Cooper.*
301. Chrysodomus sitchana, *Midd.*
302. Trophon cancellinum, *Phil.*
303. Trophon corrugatum, *Rve.*
304. Trophon orpheus, *Gld.*
305. Pteronotus festivus, *Hds.*

CHECK LIST

OF THE

SHELLS OF NORTH AMERICA.

WEST COAST:

MEXICAN AND PANAMIC PROVINCE.

BY

P. P. CARPENTER.

THE West Tropical fauna of America is known to extend from Guaymas in the Gulf of California, to the shores of Ecuador and Peru; and includes the Galapagos Islands. This list contains the Panama Shells of Prof. C. B. Adams; the Mazatlan Shells of the British Museum Catalogue; the species from various sources enumerated in the "Report on the Present State of our Knowledge of the Molluska of the West Coast of N. America," —British Association, 1856, pp. 289 *et seq.;* and a few since discovered. The synonyms, stragglers from other faunas, and the insular and South American species are omitted. Being prepared simply for the interchange of named specimens, it should not be cited as an authority.

BRYOZOA.

Membraniporidæ.

1. Membranipora denticulata, *B.*
2. Membranipora gothica, *Ryl.*
3. Lepralia adpressa, *Busk.*
4. Lepralia atrofusca, *Ryl.*
5. Lepralia hippocrepis, *Busk.*
6. Lepralia humilis, *Busk.*
7. Lepralia marginipora, *Reuss.*
8. Lepralia mazatlanica, *Busk.*
9. Lepralia rostrata, *Busk.*
10. Lepralia trispinosa, *Johnst.*

Celleporidæ.

11. Cellepora cyclostoma, *Busk.*
12. Cellepora papillæformis, *Busk.*

Discoporidæ.

13. Defrancia intricata, *Busk.*

PALLIOBRANCHIATA.

14. Discina Cumingii, *Brod.*

LAMELLIBRANCHIATA.

Pholadidæ.

15. Pholas cornea.
16. Pholas crucigera, *Sby.*
17. Pholadidea curta, *Sby.*
18. Pholadidea melanura, *Sby.*
19. Pholadidea tubifera, *Sby.*
20. Parapholas acuminata, *Sby.*
21. Parapholas calva, *Gray.*
22. Martesia intercalata, *Cpr.*
23. Martesia xylophaga, *Val.*

Gastrochænidæ.

24. Gastrochæna ovata, *Sby.*
25. Gastrochæna truncata, *Sby.*

Saxicavidæ.

26. Saxicava ?arctica, *Linn.*

Corbulidæ.

27. Sphænia fragilis, *Cpr.*
28. Potamomya æqualis, *C. B. Ad.*
29. Potamomya inflata, *C. B. Ad.*

30. Potamomya trigonalis, *C. B. A.*
31. Corbula bicarinata, *Sby.*
32. Corbula biradiata, *Sby.*
33. Corbula Boivinei.
34. Corbula fragilis, *Hds.*
35. Corbula marmorata, *Hds.*
36. Corbula nasuta, *Sby.*
37. Corbula nuciformis, *Sby.*
38. Corbula obesa, *Hds.*
39. Corbula ovulata, *Sby.*
40. Corbula pustulosa, *Cpr.*
41. Corbula radiata.
42. Corbula rubra, *C. B. Ad.*
43. Corbula speciosa, *Hds.*
44. Corbula tenuis, *Sby.*
45. Corbula ventricosa, *Rve.*

Anatinidæ.

46. Thracia squamosa, *Cpr.*
47. Tyleria fragilis, *H. & A. Ad.*
48. Lyonsia diaphana, *Cpr.*
49. Lyonsia picta, *Sby.*
50. Periploma alta, *C. B. Ad.*
51. Periploma excurvata, *Cpr.*
52. Periploma Leana, *Conr.*
53. Periploma papyracea, *Cpr.*
54. Periploma planiuscula, *Sby.*
55. Neæra costata, *Hds.*
56. Neæra didyma, *Hds.*
57. Pandora brevifrons.
58. Pandora claviculata, *Cpr.*
59. Pandora cornuta, *C. B. Ad.*

Solenidæ.

60. Solen rudis, *C. B. Ad.*

Solecurtidæ.

61. Solecurtus affinis, *C. B. Ad.*
62. Solecurtus politus, *Cpr.*
63. Solecurtus violascens, *Cpr.*
64. Sanguinolaria miniata, *Gld.*
65. Sanguinolaria tellinoides, *Ad.*
66. Psammobia Kindermanni, *Phil.*
67. Tellina brevirostris, *Desh.*
68. Tellina Broderipii, *Desh.*
69. Tellina cognata, *C. B. Ad.*
70. Tellina columbiensis, *Hanl.*
71. Tellina crystallina, *Chemn.*
72. Tellina Cumingii, *Hanl.*
73. Tellina delicatula, *Desh.*
74. Tellina denticulata, *Desh.*
75. Tellina Deshayesii, *Cpr.*
76. Tellina donacilla, *Cpr.*
77. Tellina eburnea, *Hanl.*
78. Tellina fausta, *Donov.*
79. Tellina felix, *Hanl.*
80. Tellina gemma, *Gld.*
81. Tellina hiberna, *Hanl.*
82. Tellina insculpta, *Hanl.*
83. Tellina laceridens, *Hanl.*
84. Tellina lamellata, *Cpr.*
85. Tellina panamensis.
86. Tellina princeps, *Hanl.*
87. Tellina prora, *Hanl.*
88. Tellina puella, *C. B. Ad.*
89. Tellina punicea, *Born.*
90. Tellina pura, *Gld.*
91. Tellina regia, *Hanl.*
92. Tellina regularis, *Cpr.*
93. Tellina rhodora, *Hanl*
94. Tellina rubescens, *Hanl.*
95. Tellina rufescens, *Chemn.*
96. Tellina siliqua, *C. B. Ad.*
97. Tellina straminea, *Desh.*
98. Tellina virgo, *Hanl.*
99. Macoma aurora, *Hanl.*
100. Macoma concinna, *C. B. Ad.*
101. Macoma Dombeyi, *Hanl.*
102. Macoma elongata, *Hanl.*
103. Macoma gubernaculum, *Hanl*
104. Macoma mazatlanica, *Desh.*
105. Macoma petalum, *Val.*
106. Macoma plebeia, *Hanl.*
107. Macoma tersa, *Gld.*
108. Strigilla carnaria, *Linn.*
109. Strigilla dichotoma, *Phil.*
110. Strigilla disjuncta, *Cpr.*
111. Strigilla ervilia, *Phil.*
112. Strigilla lenticula, *Phil.*
113. Strigilla sincera, *Hanl.*
114. Tellidora Burneti, *Brod. & Sby.*
115. ?Scrobicularia producta, *Cpr.*
116. ?Scrobicularia viriditincta, *C*
117. Semele bicolor, *C. B. Ad.*.
118. Semele californica, *A. Ad.*
119. Semele elliptica, *Sby.*
120. Semele flavescens, *Gld.*
121. Semele obliqua, *Wood.*
122. Semele planata.
123. Semele proxima, *C. B. Ad.*
124. Semele pulchra, *Sby.*
125. Semele striosa, *C. B. Ad.*
126. Semele tortuosa, *C. B. Ad.*
127. Semele ventricosa, *C. B. Ad.*
128. Semele ?venusta, *A. Ad.*
129. Cumingia californica, *Conr.*
130. Cumingia lamellosa, *Sby.*
131. Cumingia trigonularis, *Sby.*
132. Cumingia

Donacidæ.

133. Iphigenia altior, *Sby.*
134. Iphigenia lævigata, *Gmel.*
135. Arcopagia vicina, *C. B. Ad.*

136. Donax assimilis, *Hanl.*
137. Donax bella, *Desh.*
138. Donax cælatus, *Cpr.*
139. Donax carinatus, *Hanl.*
140. Donax Carpenteri, *H. & A. Ad.*
141. Donax Conradi, *Desh.*
142. Donax culminatus, *Cpr.*
143. Donax gracilis, *Hanl.*
144. Donax navicula, *Hanl.*
145. Donax ovalina, *Desh.*
146. Donax panamensis.
147. Donax punctatostriatus, *Hanl.*
148. Donax transversus, *Sby.*

Mactridæ.

149. Mactra angulata, *Gray.*
150. Mactra angusta, *Desh.*
151. Mactra californica, *Desh.*
152. Mactra exoleta, *Gray.*
153. Mactra fragilis, *Chemn.*
154. Mactra goniata, *Gray.*
155. Mactra laciniata.
156. Mactra pallida.
157. Mactra velata, *Phil.*
158. Raeta elegans, *Sby.*
159. Rangia mendica, *Gld.*

Veneridæ.

160. Clementia gracillima, *Cpr*
161. Trigona argentina, *Sby.*
162. Trigona humilis, *Cpr.*
163. Trigona planulata, *Sby.*
164. Trigona radiata, *Sby.*
165. Dosinia Annæ, *Cpr.*
166. Dosinia Dunkeri, *Phil.*
167. Dosinia ponderosa, *Gray.*
168. Cyclina producta, *Cpr.*
169. Cyclina subquadrata, *Hanl.*
170. Dione aurantia, *Hanl.*
171. Dione brevispinosa, *Sby.*
172. Dione chionæa, *Mke.*
173. Dione circinata, *Born.*
174. Dione concinna, *Sby.*
175. Dione consanguinea, *C. B. Ad.*
176. Dione lupinaria, *Less.*
177. Dione rosea, *Brod. & Sby.*
178. Dione unicolor, *Sby.*
179. Dione vulnerata, *Brod.*
180. Cytherea petichialis, *Lam.*
181. Venus amathusia, *Phil.*
182. Venus californiensis, *Brod.*
183. Venus columbiensis, *Sby.*
184. Venus crenifera, *Sby.*
185. Venus distans, *Phil.*
186. Venus fluctifraga, *Sby.*
187. Venus fuscolineata, *Br. & Sby.*
188. Venus gnidia, *Brod. & Sby.*
189. Venus Kellettii, *Hds.*
190. Venus multicostata, *Sby.*
191. Venus neglecta, *Gray.*
192. Venus ornatissima, *Brod.*
193. Venus pulicaria, *Brod.*
194. Venus reticulata, *Ln.*
195. Venus undatella, *Sby.* [*Sby*
196. Anomalocardia subimbricata,
197. Anomalocardia subrugosa, *S.*
198. Tapes grata, *Say.*
199. Tapes histrionica, *Sby.*
200. Tapes squamosa, *Cpr.*
201. Tapes tenerrima, *Cpr.*

Petricolidæ.

202. Petricola cognata, *C. B. Ad.*
203. Petricola dactylus, *Sby.*
204. Petricola denticulata, *Sby.*
205. Petricola robusta, *Sby.*
206. Petricola ventricosa, *Desh.*
207. Rupellaria exarata, *Cpr.*
208. Rupellaria foliacea, *Desh.*
209. Rupellaria lingua-felis, *Cpr.*
210. Rupellaria paupercula, *Desh.*
211. Naranio scobina, *Cpr.*

Astartidæ.

212. Gouldia pacifica, *C. B. Ad.*
213. Gouldia varians, *Cpr.*
214. Circe margarita, *Cpr.*
215. Circe subtrigona, *Cpr.*
216. Crassatella gibbosa, *Sby*
217. Trapezium
218. Cardita affinis, *Brod.*
219. Cardita californica, *Desh.*
220. Cardita crassa, *Gray.*
221. Cardita Cuvieri, *Brod.*
222. Cardita laticostata, *Sby.*
223. Cardita radiata, *Brod.*

Chamidæ.

224. Chama Buddiana, *C. B. Ad.*
225. Chama corrugata, *Brod.*
226. Chama echinata, *Brod.*
227. Chama exogyra, *Conr.*
228. Chama frondosa, *Brod.*
229. Chama panamensis, *Rve.*
230. Chama producta, *Brod.*
231. Chama spinosa, *Sby.*

Cardiadæ.

232. Cardium alabastrum, *Cpr.*
233. Cardium Belcheri, *Brod. & Sby.*
234. Cardium biangulatum, *B. & Sby.*
235. Cardium consors, *Brod. & Sby.*
236. Cardium Cumingii, *Brod.*
237. Cardium elatum, *Sby.*
238. Cardium graniferum, *Brod. & S.*
239. Cardium maculosum. *Wood.*

240. Cardium obovale, *Brod. & Sby.*
241. Cardium panamense, *Sby.*
242. Cardium procerum, *Sby.*
243. Cardium rotundatum, *Cpr.*
244. Cardium senticosum, *Sby.*

Lucinidæ.

245. Codakia punctata, *Linn.*
246. Codakia tigerina, *Linn.*
247. Lucina annulata, *Rve.*
248. Lucina artemidis, *Cpr.*
249. Lucina eburnea, *Rve.*
250. Lucina excavata, *Cpr.*
251. Lucina fenestrata.
252. Lucina mazatlanica, *Cpr.*
253. Lucina muricata, *Chemn.*
254. Lucina pectinata, *Cpr.*
255. Lucina prolongata, *Cpr.*

Diplodontidæ.

256. Diplodonta calculus, *Rve.*
257. Diplodonta obliqua, *Phil.*
258. Diplodonta semiaspera, *Phil.*
259. Diplodonta subquadrata, *Cpr.*
260. Felania cornea, *Rve.*
261. Felania serricata, *Rve.*
262. Felania tellinoides, *Rve.*

Kelliadæ.

263. Kellia suborbicularis, *Mont.*
264. Lasea oblonga, *Cpr.*
265. Lasea ?rubra, *Mont.*
266. Lasea trigonalis, *Cpr.*
267. Lepton clementinum, *Cpr.*
268. Lepton dionæum, *Cpr.*
269. Lepton obtusum, *Cpr.*
270. Lepton umbonatum, *Cpr.*
271. Pythina sublævis, *Cpr.*
272. Montacuta chalcedonica, *Cpr.*
273. Montacuta elliptica, *Cpr.*
274. Montacuta subquadrata, *Cpr.*
275. Scintilla Cumingii, *Desh.*
276. [Cycladella papyracea.]

Mytilidæ.

277. Mytilus multiformis, *Cpr.*
278. Mytilus palliopunctatus, *Dkr.*
279. Septifer Cumingianus, *Dkr.*
280. Modiola braziliensis, *Chemn.*
281. Modiola capax, *Conr.*
282. Modiola mutabilis, *Cpr.*
283. Crenella coarctata, *Dkr.*
284. Lithophagus aristatus, *Sol.*
285. Lithophagus attenuatus, *Desh.*
286. Lithophagus calyculatus, *Cpr.*
287. Lithophagus cinnamomeus, *L.*
288. Lithophagus plumula, *Hank.*
289. Leiosolenus spatiosus, *Cpr.*

Arcadæ.

290. Arca cardiiformis, *Sby.*
291. Arca concinna.
292. Arca formosa, *Sby.*
293. Arca grandis, *Brod. & Sby.*
294. Arca multicostata, *Sby.*
295. Arca tuberculosa, *Sby.*
296. Scapharca bifrons, *Cpr.*
297. Scapharca emarginata, *Sby.*
298. Scapharca labiata, *Sby.*
299. Scapharca nux, *Sby.*
300. Noetia reversa, *Gray.*
301. Argina brevifrons, *Sby.*
302. Byssoarca alternata, *Sby.*
303. Byssoarca aviculoides, *Rve.*
304. Byssoarca gradata, *Brod. & Sby*
305. Byssoarca illota, *Sby.*
306. Byssoarca mutabilis, *Sby.*
307. Byssoarca pacifica, *Sby.*
308. Byssoarca Reeviana, *D'Orb.*
309. Byssoarca solida, *Sby.*
310. Byssoarca vespertilio, *Cpr.*
311. Axinæa bicolor, *Rve.*
312. Axinæa gigantea, *Rve.*
313. Axinæa inæqualis, *Sby.*
314. Axinæa maculata, *Brod.*
315. Axinæa multicostata, *Say.*
316. Axinæa parcipicta.
317. Axinæa pectenoides.
318. Nucinella

Nuculidæ.

319. Nucula exigua, *Sby.*
320. Leda costellata, *Sby.*
321. Leda crispa, *Hds.*
322. Leda elenensis, *Sby.*
323. Leda excavata, *Hds.*
324. Leda gibbosa, *Sby.*
325. Leda lyrata, *Hds*
326. Leda polita, *Sby.*

Aviculidæ.

327. Pinna lanceolata, *Sby.*
328. Pinna maura, *Sby.*
329. Pinna rugosa, *Sby.*
330. Pinna tuberculosa, *Sby.*
331. Avicula sterna, *Gld.*
332. Margaritiphora fimbriata, *Dkr*
333. Isognomon Chemnitzianus, [*D'Orb.*
334. Isognomon janus, *Cpr.*

Pectenidæ.

335. Pecten circularis, *Sby.*
336. Pecten fasciculatus, *Hds.*
337. Pecten nodosus, *Ln.*
338. Pecten subnodosus, *Sby.*
339. Pecten tumbezensis, *D'Orb.*
340. Pecten ventricosus, *Sby*

341. Janira dentata, *Sby.*
342. Janira sericea, *Hds.*
343. Lima angulata, *Sby.*
344. Lima arcuata, *Sby.*
345. Lima pacifica, *D'Orb.*
346. Lima tetrica, *Gld.*

Spondylidæ.

347. Spondylus calcifer, *Cpr.*
348. Spondylus dubius.
349. Spondylus limbatus, *Sby.*
350. Spondylus princeps, *Brod.*
351. Spondylus radula, *Rve.*
352. Plicatula penicillata, *Cpr.*

Ostreadæ.

353. Ostrea columbiensis, *Hanl.*
354. Ostrea conchaphila, *Cpr.*
355. Ostrea Cumingiana, *Dkr.*
356. Ostrea iridescens, *Gray.*
357. Ostrea palmula, *Cpr.*
358. Ostrea ?Virginica, *Gmel.*

Anomiadæ.

359. Placunanomia claviculata, *C.*
360. Placunanomia Cumingii, *Brod.*
361. Placunanomia foliata, *Brod.*
362. Placunanomia pernoides, *Gray.*
363. Anomia fidenas, *Gray.*
364. Anomia lampe, *Gray.*

GASTEROPODA OPISTHOBRANCHIATA.

Pleurobranchidæ.

365. Umbrella ovalis, *Cpr.*

Philinidæ.

366. Smaragdinella thecaphora, *C.*

Bullidæ.

367. Bulla Adamsi, *Mke.*
368. Bulla exarata, *Cpr.*
369. Bulla nebulosa, *Gld.*
370. Bulla panamensis, *Phil.*
371. Bulla Quoyii, *Gray.*
372. Haminea cymbiformis, *Cpr.*
373. Haminea vesicula, *Gld.*

Cylichnidæ.

374. Cylichna luticola, *C. B. Ad.*
375. Tornatina carinata, *Cpr.*
376. Tornatina infrequens, *C. B. Ad.*

GASTEROPODA PULMONATA.

Auriculidæ.

377. Melampus acutus, *D'Orb.*
378. Melampus Bridgesii, *Cpr.*
379. Melampus concinnus, *C. B. Ad.*
380. Melampus infrequens, *C.B.Ad.*
381. Melampus olivaceus, *Cpr.*
382. Melampus panamensis, *C. B. A.*
383. Melampus stagnalis, *D'Orb.*
384. Melampus tabogensis, *C. B. A.*
385. Melampus trilineatus, *C.B. Ad.*
386. Pedipes angulata, *C. B. Ad.*

Siphonariadæ.

387. Siphonaria æquilirata, *Cpr.*
388. Siphonaria costata, *Sby.*
389. Siphonaria gigas, *Sby.*
390. Siphonaria lecanium, *Phil.*
391. Siphonaria maura, *Sby*
392. Siphonaria pica, *Sby.*

GASTEROPODA PROSOBRANCHIATA.

HETEROPODA.

Ianthinidæ.

393. Ianthina decollata, *Cpr.*
394. Ianthina striulata, *Cpr.*
395. Recluzia Rollandiana, *Phil.*

CIRRIBRANCHIATA.

Dentaliadæ.

396. Dentalium corrugatum, *Cpr.*
397. Dentalium hyalinum, *Phil.*
398. Dentalium liratum, *Cpr.*
399. Dentalium pretiosum, *Sby.*
400. Dentalium tessaragonum.

SCUTIBRANCHIATA.

Chitonidæ.

401. Lophyrus albolineatus, *B. & S.*
402. Lophyrus articulatus, *B. & Sby.*
403. Lophyrus dispar, *Sby.*
404. Lophyrus lævigatus, *Sby.*
405. Lophyrus Stokesii, *Brod.*
406. Lophyrus striatosquamosus, *C.*
407. Callochiton pulchellus, *Gray.*
408. Lepidopleurus Beanii, *Cpr.*
409. Lepidopleurus bullatus, *Cpr.*
410. Lepidopleurus clathratus, *Cpr.*
411. Lepidopleurus magdalensis, *H.*
412. Lepidopleurus M'Andreæ, *C.*
413. Lepidopleurus sanguineus, *R.*
414. Lepidochiton proprius, *Rve.*
415. Tonicia crenulata, *Brod.*
416. Tonicia Forbesii, *Cpr.*
417. Tonicia lineata, *Wood.*
418. [Chiton] clathratus, *Rve.*
419. Chiton columbiensis, *Sby.*
420. [Chiton] Elenensis, *Sby.*
421. Chiton flavescens, *Cpr.*
422. Chiton luridus, *Sby.*
423. Chiton scabricula, *Sby.*
424. [Chiton] setosus, *Sby.*
425. Mopalia Hindsii, *Sby.*

426. Acanthochites arragonites, *C.*
427. Plaxiphora retusa, *Sby.*

Patellidæ.

428. Patella discors, *Phil.*
429. Patella mexicana, *Brod. & Sby.*
430. Patella pediculus, *Phil.*
431. Patella stipulata, *Rve.*
432. Nacella

Acmæidæ.

433. Acmæa fascicularis, *Mke.*
434. Acmæa livescens, *Rve.*
435. Acmæa mesoleuca, *Mke.*
436. Acmæa mitella, *Mke.*
437. Acmæa scabra, *Nutt.*
438. Acmæa vespertina, *Rve.*
439. Scutellina navicelloides, *Cpr.*

Gadiniadæ.

440. Gadinia pentegoniostoma, *Sby.*

Fissurellidæ.

441. Fissurella alba, *Cpr.*
442. Fissurella crenifera, *Sby.*
443. Fissurella macrotrema, *Sby.*
444. Fissurella mexicana, *Sby.*
445. Fissurella microtrema, *Sby.*
446. Fissurella mus, *Rve.*
447. Fissurella nigrocincta, *Cpr.*
448. Fissurella nigropunctata, *Sby.*
449. Fissurella ostrina, *Rve.*
450. Fissurella rugosa, *Sby.*
451. Fissurella spongiosa, *Cpr.*
452. Fissurella virescens, *Sby.*
453. Glyphis alta, *C. B. Ad.*
454. Glyphis gibberula, *Lam.*
455. Glyphis inæqualis, *Sby.*
456. Glyphis panamensis, *Sby.*
457. Fissurellidæa æqualis, *Sby.*
458. Rimula mazatlanica, *Cpr.*

Trochidæ.

459. Phasianella compta, *Gld.*
460. Phasianella perforata, *Phil.*
461. Callopoma fluctuosum, *Mawe.*
462. Callopoma saxosum, *Wood.*
463. Collonia phasianella, *C. B. Ad.*
464. Turbo rutilus, *C. B. Ad.*
465. Turbo squamigera, *Rve.*
466. Uvanilla inermis, *Gmel.*
467. Uvanilla olivacea, *Mawe.*
468. Uvanilla unguis, *Mawe.*
469. Ziziphinus Leanus, *C. B. Ad.*
470. Ziziphinus lima, *Phil.*
471. Ziziphinus M'Andreæ, *Cpr.*
472. Ziziphinus panamensis, *Phil.*
473. Ziziphinus versicolor, *Mke.*
474. Tegula pellis-serpentis, *Wood.*
475. Gibbula coronulata, *C. B. Ad.*
476. Omphalius globulus, *Cpr.*
477. Omphalius ligulatus, *Mke.*
478. Omphalius rugosus, *A. Ad.*
479. Omphalius viridulus, *Gmel.*
480. Polydonta dentata, *A. Ad.*
481. Vitrinella annulata, *Cpr.*
482. Vitrinella bifilata, *Cpr.*
483. Vitrinella bifrontia, *Cpr.*
484. Vitrinella carinulata, *Cpr.*
485. Vitrinella cincta, *Cpr.*
486. Vitrinella concinna, *C. B. Ad.*
487. Vitrinella coronata, *Cpr.*
488. Vitrinella decussata, *Cpr.*
489. Vitrinella exigua, *C. B. Ad.*
490. Vitrinella janus, *C. B. Ad.*
491. Vitrinella lirulata, *Cpr.*
492. Vitrinella modesta, *C. B. Ad.*
493. Vitrinella monilifera, *Cpr.*
494. Vitrinella monilis, *Cpr.*
495. Vitrinella orbis, *Cpr.*
496. Vitrinella panamensis, *C. B. A.*
497. Vitrinella parva, *C. B. Ad.*
498. Vitrinella perparva, *C. B. Ad.*
499. Vitrinella planospirata, *Cpr.*
500. Vitrinella regularis, *C. B. Ad.*
501. Vitrinella seminuda, *C. B. Ad.*
502. Vitrinella subquadrata, *Cpr.*
503. Vitrinella tricarinata, *C. B. Ad.*
504. Ethalia amplectans, *Cpr.*
505. Ethalia carinata, *Cpr.*
506. Ethalia lirulata, *Cpr.*
507. Ethalia naticoides, *Cpr.*
508. Ethalia pallidula, *Cpr.*
509. Ethalia pyricallosa, *Cpr*
510. Ethalia valvatoides, *C. B. Ad.*
511. Teinostoma amplectans, *Cpr.*
512. Teinostoma minutum, *C.B.Ad.*
513. Teinostoma substriatum, *Cpr.*
514. Globulus sulcatus, *Cpr.*
515. Globulus tumens, *Cpr.*
516. Adeorbis scaber, *Phil.*

Neritidæ.

517. Nerita Bernhardi, *Recl.*
518. Nerita scabricosta, *Lam.*
519. Neritina californica, *Rve.*
520. Neritina cassiculum, *Sby.*
521. Neritina globosa, *Brod.*
522. Neritina guayaquilensis, *Sby.*
523. Neritina intermedia, *Sby.*
524. Neritina latissima, *Brod.*
525. Neritina Listeri, *Pfr.*
526. Neritina Michaudi, *Récl.*
527. Neritina picta, *Sby.*
528. Neritina pulchra, *Wood.*

PECTINIBRANCHIATA.

ROSTRIFERA.

Naricidæ.

529. Narica cryptophila, *Cpr.*

Calyptræidæ.

530. Crucibulum imbricatum, *Sby.*
531. Crucibulum Jewettii, *Cpr.*
532. Crucibulum radiatum, *Brod.*
533. Crucibulum serratum.
534. Crucibulum spinosum, *Sby.*
535. Crucibulum umbrella, *Desh.*
536. Calyptræa cepacea, *Brod.*
537. Calyptræa corrugata, *Brod.*
538. Calyptræa planulata, *Brod.*
539. Galerus conicus, *Brod.*
540. Galerus mamillaris, *Brod.*
541. Galerus sordidus, *Brod.*
542. Galerus subreflexus, *Cpr.*
543. Galerus unguis, *Brod.*
544. Trochita spirata, *Forbes.*
545. Trochita ventricosa, *Cpr.*
546. Crepidula aculeata, *Gmel.*
547. Crepidula adunca, *Sby.*
548. Crepidula arenata, *Brod.*
549. Crepidula dorsata, *Brod.*
550. Crepidula excavata, *Brod.*
551. Crepidula incurva, *Brod.*
552. Crepidula marginalis, *Brod.*
553. Crepidula nivea, *C. B. Ad.*
554. Crepidula onyx, *Sby.*
555. Crepidula unguiformis, *Lam.*

Capulidæ.

556. Hipponyx antiquatus, *Linn.*
557. Hipponyx barbatus, *Sby.*
558. Hipponyx Grayanus, *Mke.*
559. Hipponyx mitrula, *Sby.*
560. Hipponyx planatus, *Cpr.*
561. Hipponyx serratus, *Cpr.*
562. Capulus

Vermetidæ.

563. Aletes centiquadrus, *Val.*
564. Aletes margaritarum, *Val.*
565. Vermetus eburneus, *Rve.*
566. Vermetus Hindsii, *Gray.*
567. Bivonia albida, *Cpr.*
568. Bivonia contorta, *Cpr.*
569. Petaloconchus macrophragma, *Cpr.*

Cæcidæ.

570. Cæcum abnormale, *Cpr.*
571. Cæcum clathratum, *Cpr.*
572. Cæcum corrugulatum, *Cpr.*
573. Cæcum dextroversum, *Cpr.*
574. Cæcum elongatum, *Cpr.*
575. Cæcum farcimen, *Cpr.*
576. Cæcum firmatum, *C. B. Ad.*
577. Cæcum glabriforme, *Cpr.*
578. Cæcum heptagonum, *Cpr.*
579. Cæcum insculptum, *Cpr.*
580. Cæcum læve, *C. B. Ad.*
581. Cæcum laqueatum, *C. B. Ad*
582. Cæcum liratocinctum, *Cpr*
583. Cæcum obtusum, *Cpr.*
584. Cæcum quadratum, *Cpr.*
585. Cæcum reversum, *Cpr.*
586. Cæcum subimpressum, *Cpr.*
587. Cæcum subspirale, *Cpr.*
588. Cæcum teres, *Cpr.*
589. Cæcum undatum, *Cpr.*

Turritellidæ.

590. Turritella fascialis, *Rve.*
591. Turritella goniostoma, *Val.*
592. Turritella nodulosa, *King.*
593. Turritella rubescens, *Rve.*
594. Turritella tigrina, *Kien.*

Cerithiadæ.

595. Cerithium alboliratum, *Cpr.*
596. Cerithium famelicum, *C. B. Ad.*
597. Cerithium interruptum, *Mke.*
598. Cerithium irroratum, *C. B. Ad.*
599. Cerithium maculosum, *Kien.*
600. Cerithium musicum, *Val.*
601. Cerithium pacificum, *Sby.*
602. Cerithium stercusmuscarum, *V.*
603. Cerithium uncinatum, *Gmel.*
604. Vertagus fragraria, *Val.*
605. Vertagus gemmatus, *Hds.*
606. Cerithidea mazatlanica, *Cpr.*
607. Cerithidea Montagnei, *D'Orb.*
608. Cerithidea pulchra, *C. B. Ad.*
609. Cerithidea varicosa, *Sby.*

Truncatellidæ.

610. Truncatella Bairdiana, *C.B.Ad.*

Melaniadæ.

611. Melania Gouldii, *H. & A. Ad.*
612. Pyrgula quadricostata, *Cpr.*

Ampullaridæ.

613. Ampullaria Cumingii, *King.*
614. Ampullaria malleata.

Litorinidæ.

615. Litorina aberrans, *Phil.*
616. Litorina aspera, *Phil.*
617. Litorina conspersa, *Phil.*
618. Litorina coronata, *Lam.*
619. Litorina fasciata, *Gray.*
620. Litorina Philippii, *Cpr.*
621. Litorina pulchra, *Phil.*
622. Litorina varia, *Sby.*
623. Modulus catenulatus, *Phil.*
624. Modulus disculus, *Phil.*

625. Fossarus abjectus, *C. B. Ad.*
626. Fossarus angiostoma, *C. B. Ad.*
627. Fossarus angulatus, *Cpr.*
628. Fossarus excavatus, *C. B. Ad.*
629. Fossarus foveatus, *C. B. Ad.*
630. Fossarus megasoma, *C. B. Ad.*
631. Fossarus tuberosus, *Cpr.*
632. Isapis maculosa, *Cpr.*
633. Isapis ovoidea, *Gld.*

Rissoidæ.

634. Rissoina clandestina, *C. B. Ad.*
635. Rissoina firmata, *C. B. Ad.*
636. Rissoina fortis, *C. B. Ad.*
637. Rissoina infrequens, *C. B. Ad.*
638. Rissoina janus, *C. B. Ad.*
639. Rissoina stricta, *Mke.*
640. Rissoina Woodwardii, *Cpr.*
641. Barleeia lirata, *Cpr.*
642. Alvania effusa, *Cpr.*
643. Alvania excurvata, *Cpr.*
644. Alvania tumida, *Cpr.*
645. ?Cingula dubiosa, *C. B. Ad.*
646. Cingula paupercula, *C. B. Ad.*
647. Cingula saxicola, *C. B. Ad.*
648. Hydrobia ?ulvæ, *Penn.*

Jeffreysiadæ.

649. Jeffreysia Alderi, *Cpr.*
650. Jeffreysia bifasciata, *Cpr.*
651. Jeffreysia tumens, *Cpr.*

Planaxidæ.

652. Alaba alabastrites, *Cpr.*
653. Alaba conica, *Cpr.*
654. Alaba laguncula, *Cpr.*
655. Alaba mutans, *Cpr.*
656. Alaba scalata, *Cpr.*
657. Alaba supralirata, *Cpr.*
658. Alaba terebralis, *Cpr.*
659. Alaba violacea, *Cpr.*
660. Planaxis nigritella, *Forbes.*
661. Planaxis planicostata, *Sby.*

Ovulidæ.

662. Radius æqualis.
663. Radius avena, *Sby.*
664. Radius inflexus, *Sby.*
665. Radius variabilis, *C. B. Ad.*
666. Ovula emarginata, *Sby.*

Cypræidæ.

667. Cypræa exanthema, *Linn.*
668. Aricia arabicula, *Lam.*
669. Aricia punctulata, *Gray.*
670. Trivia pacifica, *Gray.*
671. Trivia pulla, *Gask.*
672. Trivia pustulata, *Lam.*
673. Trivia radians, *Lam.*
674. Trivia rubescens, *Gray.*
675. Trivia sanguinea, *Gray.*
676. Trivia Solandri, *Gray.*
677. Trivia ?suffusa, *Gray.*
678. Erato columbella, *Mke.*
679. Erato Maugeriæ, *Gray.*
680. Erato scabriuscula, *Gray.*

Cancellariadæ.

681. Cancellaria acuminata, *Sby.*
682. Cancellaria affinis, *C. B. Ad.*
683. Cancellaria albida, *Hds.*
684. Cancellaria bifasciata.
685. Cancellaria brevis, *Sby.*
686. Cancellaria buccinoides, *Sby.*
687. Cancellaria bulbulus, *Sby.*
688. Cancellaria bullata, *Sby.*
689. Cancellaria candida, *Sby.*
690. Cancellaria cassidiformis, *Sby*
691. Cancellaria chrysostoma, *Sby.*
692. Cancellaria clavatula, *Sby.*
693. Cancellaria crenata, *Hds.*
694. Cancellaria decussata, *Sby.*
695. Cancellaria elata, *Hds.*
696. Cancellaria gemmulata, *Sby.*
697. Cancellaria goniostoma, *Sby.*
698. Cancellaria indentata, *Sby.*
699. Cancellaria obesa, *Sby.*
700. Cancellaria pulchra, *Sby.*
701. Cancellaria pygmæa, *C. B. Ad*
702. Cancellaria solida, *Sby.*
703. Cancellaria tessellata, *Sby.*
704. Cancellaria uniplicata, *Sby.*
705. Cancellaria urceolata, *Hds.*
706. Cancellaria ventricosa, *Hds.*

Strombidæ.

707. Strombus galeatus, *Wood.*
708. Strombus gracilior, *Sby.*
709. Strombus granulatus, *Swains.*
710. Strombus peruvianus, *Swains.*

TOXIFERA.

Terebridæ.

711. Subula luctuosa, *Hds.*
712. Subula strigata, *Sby.*
713. Subula varicosa, *Hds.*
714. Euryta aciculata, *Hds.*
715. Euryta fulgurata, *Phil.*
716. Terebra lingualis, *Hds.*
717. Terebra ornata, *Gray.*
718. Terebra robusta, *Hds.*
719. Terebra specillata, *Hds.*
720. Terebra uva.
721. Myurella albocincta, *Cpr.*
722. Myurella armillata, *Hds.*
723. Myurella aspera, *Hds.*
724. Myurella elata, *Hds.*

725. Myurella Hindsii, *Cpr.*
726. Myurella larvæformis, *Hds.*
727. Myurella rufocinerea, *Cpr.*
728. Myurella subnodosa, *Cpr.*
729. Myurella tuberculosa, *Hds.*
730. Myurella variegata, *Gray.*

Pleurotomidæ.

731. Pleurotoma arcuata, *Rve.*
732. Pleurotoma bituberculifera.
733. Pleurotoma cedo-nulli, *Rve.*
734. Pleurotoma clavulus, *Sby.*
735. Pleurotoma funiculata, *Val.*
736. Pleurotoma gracillima.
737. Pleurotoma maculosa, *Sby.*
738. Pleurotoma nobilis, *Hds.*
739. Pleurotoma olivacea, *Sby.*
740. Pleurotoma oxytropis, *Sby.*
741. Pleurotoma picta, *Beck.*
742. Pleurotoma pudica, *Hds.*
743. Pleurotoma tuberculifera, *Brod.*
744. Pleurotoma unimaculata, *Sby.*
745. Drillia albonodosa, *Cpr.*
746. Drillia albovallosa, *Cpr.*
747. Drillia aterrima, *Sby.*
748. Drillia bicolor, *Sby.*
749. Drillia cælebs.
750. Drillia cerithoidea, *Cpr.*
751. Drillia collaris, *Sby.*
752. Drillia corrugata, *Sby.*
753. Drillia duplicata, *Sby.*
754. Drillia excentrica, *Sby.*
755. Drillia grandimaculata, *C.B.A.*
756. Drillia granulosa, *Sby.*
757. Drillia Hanleyi, *Cpr.*
758. Drillia impressa, *Hds.*
759. Drillia incrassata, *Sby.*
760. Drillia luctuosa, *Hds.*
761. Drillia militaris, *Hds.*
762. Drillia monilifera, *Cpr.*
763. Drillia nigerrima, *Sby.*
764. Drillia nitida, *Sby.*
765. Drillia obeliscus, *Rve.*
766. Drillia pallida, *Sby.*
767. Drillia pardalis, *Hds.*
768. Drillia punctatostriata.
769. Drillia rudis, *Sby.*
770. Drillia rustica, *Sby.*
771. Drillia striosa, *C. B. Ad.*
772. Drillia unicolor, *Sby.*
773. Drillia zonulata, *Rve.*
774. Clathurella aurea, *Cpr.*
775. Clathurella bella, *Hds.*
776. Clathurella bicanalifera, *Sby.*
777. Clathurella cælata, *Hds.*
778. Clathurella candida, *Hds.*
779. Clathurella cornuta.
780. Clathurella corrugata.
781. Clathurella ericea, *Hds.*
782. Clathurella exigua, *C. B. Ad.*
783. Clathurella gemmulosa, *C.B.A*
784. Clathurella intercalaris.
785. Clathurella merita, *Hds.*
786. Clathurella micans, *Hds.*
787. Clathurella neglecta, *Hds.*
788. Clathurella occata, *Hds.*
789. Clathurella quisqualis, *Hds.*
790. Clathurella rava, *Hds.*
791. Clathurella rigida, *Hds.*
792. Clathurella sculpta, *Hds.*
793. Clathurella serrata.
794. Clathurella variculosa, *Sby.*
795. Daphnella casta, *Hds.*
796. Cithara sinuata.
797. Cithara stromboides, *Rve.*
798. Mangelia acuticostata, *Cpr.*
799. Mangelia concinna, *C. B. Ad.*
800. Mangelia neglecta, *C. B. Ad.*
801. Mangelia sulcosa, *Sby.*

Conidæ.

802. Conus archon, *Brod.*
803. Conus arcuatus, *Brod. & Sby.*
804. Conus brunneus, *Wood*
805. Conus cinctus.
806. Conus concinnus, *Brod*
807. Conus ferrugatus.
808. Conus gladiator, *Brod.*
809. Conus lineolatus.
810. Conus Lorenzianus, *Chemn.*
811. Conus mahogani, *Rve.*
812. Conus nux, *Brod.*
813. Conus orion, *Brod.*
814. Conus patricius, *Hds.*
815. Conus princeps, *Linn.*
816. Conus puncticulatus, *Hwass.*
817. Conus purpurascens, *Brod.*
818. Conus pusillus, *Chemn.*
819. Conus pyriformis, *Rve.*
820. Conus ravus, *Gld.*
821. Conus regalitatis, *Sby*
822. Conus regularis, *Sby.*
823. Conus scalaris, *Val.*
824. Conus tornatus, *Brod.*
825. Conus vittatus, *Brug.*
826. Conus Ximenes, *Gray.*

PROBOSCIDIFERA.

Solariadæ.

827. Solarium granulatum, *Lam.*
828. Solarium quadriceps, *Hds.*
829. Torinia bicanaliculata.

830. Torinia granosa, *Val.*
831. Torinia variegata, *Lam.*

Pyramidellidæ.

832. Obeliscus clavulus, *A. Ad.*
833. Obeliscus conicus, *C. B. Ad.*
834. Odostomia lamellata, *Cpr.*
835. Odostomia mamillata, *Cpr.*
836. Odostomia sublirulata, *Cpr.*
837. Odostomia subsulcata, *Cpr.*
838. Odostomia tenuis, *Cpr.*
839. Odostomia vallata, *Cpr.*
840. Parthenia armata, *Cpr.*
841. Parthenia exarata, *Cpr.*
842. Parthenia lacunata, *Cpr.*
843. Parthenia quinquecincta, *Cpr.*
844. Parthenia scalariformis, *Cpr.*
845. Parthenia ziziphina, *Cpr.*
846. Chrysallida clathratula, *C.B.A.*
847. Chrysallida clausiliformis, *Cpr.*
848. Chrysallida communis, *C.B.A.*
849. Chrysallida convexa, *Cpr.*
850. Chrysallida effusa, *Cpr.*
851. Chrysallida fasciata, *Cpr.*
852. Chrysallida indentata, *Cpr.*
853. Chrysallida marginata, *C.B.Ad.*
854. Chrysallida nodosa, *Cpr.*
855. Chrysallida oblonga, *Cpr.*
856. Chrysallida ovata, *Cpr.*
857. Chrysallida ovulum, *Cpr.*
858. Chrysallida paupercula, *C.B.A.*
859. Chrysallida photis, *Cpr.*
860. Chrysallida Reigeni, *Cpr.*
861. Chrysallida rotundata, *Cpr.*
862. Chrysallida telescopium, *Cpr.*
863. Chemnitzia aculeus, *C. B. Ad.*
864. Chemnitzia acuminata, *C. B. A.*
865. Chemnitzia C-B-Adamsi, *Cpr.*
866. Chemnitzia affinis, *C. B. Ad.*
867. Chemnitzia flavescens, *Cpr.*
868. Chemnitzia gibbosa, *Cpr.*
869. Chemnitzia gracilior, *C. B. Ad.*
870. Chemnitzia gracillima, *Cpr.*
871. Chemnitzia major, *C. B. Ad.*
872. Chemnitzia muricata, *Cpr.*
873. Chemnitzia panamensis, *C.B.A.*
874. Chemnitzia prolongata, *Cpr.*
875. Chemnitzia similis, *C. B. Ad.*
876. Chemnitzia striosa, *C. B. Ad.*
877. Chemnitzia tenuilirata, *Cpr.*
878. Chemnitzia terebralis, *Cpr.*
879. Chemnitzia turrita, *C. B. Ad.*
880. Chemnitzia undata, *Cpr.*
881. Chemnitzia unifasciata, *Cpr.*
882. Dunkeria cancellata, *Cpr.*
883. Dunkeria intermedia, *Cpr.*
884. Dunkeria paucilirata, *Cpr.*
885. Dunkeria subangulata, *Cpr.*
886. Eulimella obsoleta, *Cpr.*
887. Aclis fusiformis, *Cpr.*
888. Aclis tumens, *Cpr.*

Eulimidæ.

889. Eulima acuta, *A. Ad.*
890. Eulima hastata, *Sby.*
891. Eulima interrupta.
892. Leiostraca distorta, *Phil.*
893. Leiostraca [involuta, *Cpr.*]
894. Leiostraca iota, *C. B. Ad.*
895. Leiostraca linearis, *Cpr.*
896. Leiostraca [producta, *Cpr.*]
897. Leiostraca recta, *C. B. Ad.*
898. Leiostraca retexta, *Cpr.*
899. Leiostraca solitaria, *C. B. Ad.*

Cerithiopsidæ.

900. Cerithiopsis assimilata, *C.B.A.*
901. Cerithiopsis bimarginata, *C B A*
902. Cerithiopsis cerea, *Cpr.*
903. Cerithiopsis convexa, *Cpr.*
904. Cerithiopsis decussata, *Cpr.*
905. Cerithiopsis neglecta, *C. B. A.*
906. Cerithiopsis pupiformis, *Cpr.*
907. Cerithiopsis sorex, *Cpr.*
908. Cerithiopsis tuberculoides, *C.*
909. Triforis alternatus, *C. B. Ad.*
910. Triforis inconspicuus, *C. B. Ad.*

Scalariadæ.

911. Scalaria aciculina, *Hds.*
912. Scalaria Cumingii.
913. Scalaria dianæ, *Hds.*
914. Scalaria hexagona, *Sby.*
915. Scalaria Hindsii
916. Scalaria indistincta, *Sby.*
917. Scalaria mitræformis, *Sby.*
918. Scalaria obtusa.
919. Scalaria raricostata, *Cpr.*
920. Scalaria reflexa, *Cpr.*
921. Scalaria regularis.
922. Scalaria statuminata, *Sby.*
923. Scalaria subnodosa.
924. Scalaria suprastriata, *Cpr.*
925. Scalaria tiara.
926. Scalaria vulpina, *Hds.*
927. Cirsotrema funiculata, *Cpr.*

Naticidæ.

928. Natica bifasciata, *Gray.*
929. Natica excavata, *Cpr.*
930. Natica Haneti, *Récl.*
931. Natica maroccana, *Chemn.*
932. Natica Souleyetiana, *Récl.*
933. Natica zonaria, *Récl.*
934. Lunatia Bonplandi.

935. Lunatia lurida.
936. Lunatia otis, *Brod. & Sby.*
937. Lunatia tenuilirata, *Cpr.*
938. Neverita glauca, *Val.*
939. Polinices intemerata.
940. Polinices panamensis, *Récl.*
941. Polinices salangonensis, *Récl.*
942. Polinices uber, *Val.*
943. Polinices unimaculata, *Rve.*
944. Polinices virginea, *Récl.*
945. Sigaretus debilis, *Gld.*

Lamellariadæ.

946. Lamellaria inflata, *C. B. Ad.*

Ficulidæ.

947. Ficula ventricosa, *Sby.*

Doliadæ.

948. Malea ringens, *Sby.*

Cassidæ.

949. Oniscia tuberculosa, *Rve.*
950. Cassis abbreviata, *Lam.*
951. Cassis coarctata, *Sby.*

Tritonidæ.

952. Triton anomalus, *Hds.*
953. Triton constrictus, *Brod.*
954. Triton crebristriatus.
955. Triton eximius, *Rve.*
956. Triton fusoides, *C. B. Ad.*
957. Triton gibbosus, *Brod.*
958. Triton lignarius, *Brod.*
959. Triton scalariformis, *Brod.*
960. Triton tigrinus, *Brod.*
961. Triton vestitus, *Hds.*
962. Argobuccinum nodosum, *Ch.*
963. Persona ridens, *Rve.*
964. Ranella albifasciata, *Sby.*
965. Ranella anceps, *Lam.*
966. Ranella cælata, *Brod.*
967. Ranella convoluta.
968. Ranella muriciformis, *Brod.*
969. Ranella nana, *Brod.*
970. Ranella nitida, *Brod.*
971. Ranella pectinata, *Hds.*
972. Ranella plicata, *Rve.*
973. Ranella pyramidalis.
974. Ranella triquetra, *Rve.*
975. Ranella tuberculata.

Turbinellidæ.

976. Turbinella cæstus, *Brod.*

Fasciolariadæ.

977. Lathirus armatus.
978. Lathirus californicus.
979. Lathirus castaneus, *Gray.*
980. Lathirus ceratus, *Gray.*
981. Lathirus concentricus, *Rve.*
982. Lathirus nodatus, *Mart.*
983. Lathirus rudis, *Rve.*
984. Lathirus spadiceus, *Rve.*
985. Lathirus tuberculatus, *Brod.*
986. Lathirus tumens.
987. Leucozonia cingulata, *Lam.*

Mitrinæ.

988. Mitra attenuata, *Rve.*
989. Mitra badia, *Rve.*
990. Mitra Belcheri, *Hds.*
991. Mitra funiculata, *Rve.*
992. Mitra Hindsii.
993. Mitra lens, *Wood.*
994. Mitra nucleola, *Lam.*
995. Mitra solitaria, *C. B. Ad.*
996. Mitra sulcata, *Swains.*
997. Strigatella effusa, *Swains.*
998. Strigatella tristis, *Brod.*

Volutidæ.

999. Voluta Cumingii, *Brod.*
1000. Voluta harpa, *Mawe.*
1001. Marginella cærulescens, *Lam.*
1002. Marginella curta, *Sby.*
1003. Marginella cypræola.
1004. Marginella margaritula, *Cpr.*
1005. Marginella minor, *C. B. Ad.*
1006. Marginella polita, *Cpr.*
1007. Marginella sapotilla, *Hds.*
1008. Persicula imbricata, *Hds.*

Olividæ.

1009. Oliva angulata, *Lam.*
1010. Oliva Cumingii, *Rve.*
1011. Oliva Duclosi, *Rve.*
1012. Oliva intertincta, *Cpr.*
1013. Oliva julieta, *Ducl.*
1014. Oliva Melchersi, *Mke.*
1015. Oliva porphyria, *Linn.*
1016. Oliva splendidula, *Sby.*
1017. Oliva venulata, *Lam.*
1018. Olivella anazora, *Ducl.*
1019. Olivella aureocincta, *Cpr.*
1020. Olivella dama, *Mawe.*
1021. Olivella eburnea, *Lam.*
1022. Olivella gracilis, *Gray.*
1023. Olivella inconspicua, *C. B. A.*
1024. Olivella intorta.
1025. Olivella pellucida, *Gray.*
1026. Olivella semistriata, *Gray.*
1027. Olivella tergina, *Ducl.*
1028. Olivella undatella, *Lam.*
1029. Olivella volutella, *Lam.*
1030. Olivella zonalis *Lam.*
1031. Agaronia testacea, *Lam.*
1032. Harpa crenata, *Swains.*
1033. Harpa scriba.

Purpuridæ.

1034. Purpura biserialis, *Blainv.*
1035. Purpura columellaris, *Lam.*
1036. Purpura melo, *Ducl.*
1037. Purpura muricata, *Gray.*
1038. Purpura patula, *Linn.*
1039. Purpura planospira, *Lam.*
1040. Purpura triangularis, *Blainv.*
1041. Purpura triserialis, *Blainv.*
1042. Cuma costata, *Blainv.*
1043. Cuma kiosquiformis, *Ducl.*
1044. Cuma tecta, *Wood.*
1045. Rhizocheilus asper.
1046. Rhizocheilus nux, *Rve.*
1047. Vitularia salebrosa, *King.*
1048. Monoceros brevidentatum, *G.*
1049. Monoceros lugubre, *Sby.*
1050. Monoceros tuberculatum, *Gr.*
1051. Engina alveolata, *Kien.*
1052. Engina carbonaria, *Rve.*
1053. Engina contracta, *Rve.*
1054. Engina crocostoma, *Rve.*
1055. Engina heptagonalis.
1056. Engina jugosa, *C. B. Ad.*
1057. Engina maura.
1058. Engina pyrostoma, *Sby.*
1059. Engina Reeviana, *C. B. Ad.*
1060. Nitidella cribraria, *Lam.*
1061. Nitidella pulchrior, *C. B. Ad.*

Buccinidæ.

1062. Columbella castanea, *Sby.*
1063. Columbella cervinetta, *Cpr.*
1064. Columbella festiva, *Kien.*
1065. Columbella fuscata, *Sby.*
1066. Columbella hæmastoma, *Sby.*
1067. Columbella harpiformis, *Sby.*
1068. Columbella labiosa, *Sby.*
1069. Columbella ligata.
1070. Columbella livida.
1071. Columbella major, *Sby.*
1072. Columbella nasuta.
1073. Columbella pardalis.
1074. Columbella procera.
1075. Columbella strombiformis, *L.*
1076. Metula Hindsii, *H. & A. Ad.*
1077. Truncaria modesta, *Pws.*
1078. ?Buccinum leiocheilus.
1079. ?Buccinum panamense.
1080. Nassa canescens, *C. B. Ad.*
1081. Nassa collaria, *Gld.*
1082. Nassa corpulenta, *C. B. Ad.*
1083. Nassa crebristriata, *Cpr.*
1084. Nassa festiva, *Pws.*
1085. Nassa gemmulosa, *C. B. Ad.*
1086. Nassa glauca, *C. B. Ad.*
1087. Nassa luteostoma, *Brod. & Sby*
1088. Nassa mœsta.
1089. Nassa nodifera, *Pws.*
1090. Nassa pagodus, *C. B. Ad.*
1091. Nassa pallida.
1092. ?Nassa panamensis, *C. B. Ad.*
1093. Nassa scabriuscula, *Pws.*
1094. Nassa striata, *C. B. Ad.*
1095. Nassa tegula, *Rve.*
1096. Nassa versicolor, *C. B. Ad.*
1097. Nassa Wilsoni, *C. B. Ad.*
1098. Phos articulatus, *Hds.*
1099. Phos biplicatus.
1100. Phos crassus, *Hds*
1101. Phos gaudens, *Hds*
1102. Phos turritus, *A. Ad.*
1103. Phos veraguensis, *Hds.*

Pyrulidæ.

1104. Pyrula patula, *Brod. & Sby.*

Muricidæ.

1105. Fusus ambustus.
1106. Fusus apertus, *Cpr.*
1107. Fusus bellus.
1108. Fusus Dupetithouarsii, *Kien.*
1109. Fusus lignarius, *Rve.*
1110. Fusus pallidus, *Brod. & Sby.*
1111. Fusus tumens, *Cpr.*
1112. Trophon Hindsii, *Cpr.*
1113. Anachis albonodosa, *Cpr.*
1114. Anachis atramentaria, *Sby*
1115. Anachis Boivinei, *Kien.*
1116. Anachis conspicua, *C. B. Ad*
1117. Anachis coronata, *Sby.*
1118. Anachis costellata, *Brod. & Sb.*
1119. Anachis diminuta, *C. B. Ad.*
1120. Anachis fluctuata, *Sby.*
1121. Anachis fulva, *Sby.*
1122. Anachis Gaskoinei, *Cpr*
1123. Anachis gracilis, *C. B. Ad.*
1124. Anachis lentiginosa, *Hds.*
1125. Anachis lyrata, *Sby.*
1126. Anachis mœsta, *C. B. Ad.*
1127. Anachis nigricans, *Sby.*
1128. Anachis nigrofusca, *Cpr.*
1129. Anachis nucleolus, *Phil.*
1130. Anachis pallida, *Phil.*
1131. Anachis parva, *Sby.*
1132. Anachis pygmæa, *Sby.*
1133. Anachis rufotincta, *Cpr.*
1134. Anachis rugosa, *Sby.*
1135. Anachis scalarina, *Sby.*
1136. Anachis serrata, *Cpr.*
1137. Anachis tæniata, *Phil.*
1138. Anachis tessellata, *C. B. Ad.*
1139. Anachis varia, *Sby.*

1140. Strombina angularis, *Sby.*
1141. Strombina bicanalifera, *Sby.*
1142. Strombina dorsata, *Sby.*
1143. Strombina elegans, *Sby.*
1144. Strombina fusiformis, *Hds.*
1145. Strombina gibberula, *Sby.*
1146. Strombina maculosa, *Sby.*
1147. Strombina pulcherrima, *Sby.*
1148. Strombina turrita, *Sby.*
1149. Pisania æquilirata, *Cpr.*
1150. Pisania gemmata, *Rve.*
1151. Pisania insignis, *Rve.*
1152. Pisania lugubris, *C. B. Ad.*
1153. Pisania nigrocostata, *Rve.*
1154. Pisania pagodus, *Rve.*
1155. Pisania panamensis, *Phil.*
1156. Pisania pastinaca, *Rve.*
1157. Pisania ringens, *Rve.*
1158. Pisania sanguinolenta, *Ducl.*
1159. Pisania Stimpsoniana, *C.B. A.*
1160. Northia pristis, *Desh.*
1161. Clavella distorta, *Bligh.*
1162. Murex armatus.
1163. Murex erosus, *Brod.*
1164. Murex horridus, *Brod.*
1165. Murex plicatus, *Sby.*
1166. Murex rectirostris, *Sby.*
1167. Murex recurvirostris, *Brod.*
1168. Pteronotus centrifugus, *Hds.*
1169. Phyllonotus bicolor, *Val.*
1170. Phyllonotus brassica, *Lam.*
1171. Phyllonotus imperialis, *Sw.*
1172. Phyllonotus nigritus, *Phil.*
1173. Phyllonotus nitidus, *Brod.*
1174. Phyllonotus oxyacanthus, *Br*
1175. Phyllonotus princeps, *Brod.*
1176. Phyllonotus radix, *Lam.*
1177. Phyllonotus regius, *Swains.*
1178. Muricidea alveata, *Kien.*
1179. Muricidea dubia, *Swains.*
1180. Muricidea fimbriata, *Hds*
1181. Muricidea incisa, *Brod.*
1182. Muricidea lappa, *Brod.*
1183. Muricidea pauxillus, *A. Ad.*
1184. Muricidea radicata, *Hds.*
1185. Muricidea vibex, *Brod.*
1186. Muricidea vittata, *Brod.*
1187. Typhis fimbriatus.
1188. Typhis grandis.
1189. Typhis quadratus, *Hds.*

CHECK LIST

OF THE

SHELLS OF NORTH AMERICA.

EAST COAST:

ARCTIC SEAS TO GEORGIA.

BY

WM. STIMPSON.

The following catalogue is offered as an exposition of the present state of our knowledge of the molluscous fauna of the eastern coast of North America, from the arctic seas to Georgia, inclusive. It is the result of an attentive search of all *published* accounts relating to the subject, and no species is included that has not been thus announced as an inhabitant of our shores by competent authority; although others are known to exist there, which have not yet been properly determined. All synonyms have been carefully eliminated. Under the head of "Doubtful Species" we have added a list of the names both of those the existence of which upon our coast is uncertain, and of those which will probably prove identical with species already catalogued.

BRYOZOA.

1. **Pedicellina americana**, *Leidy.*
2. **Bowerbankia gracilis**, *Leidy.*
3. **Valkeria pustulosa**, *Ellis.*
4. **Eschara foliacea**, *Linn.*
5. **Escharina variabilis**, *Leidy.*
6. **Escharina pediostoma**, *Leidy.*
7. **Escharina lineata**, *Leidy.*
8. **Flustra truncata**, *Lin.*
9. **Flustra solida**, *Stm.*
10. **Cellularia ternata**, *Ellis.*
11. **Cellularia densa**, *Desor.*
12. **Cellularia fastigiata**, *Blum.*
13. **Cellularia turrita**, *Desor.*
14. **Membranipora tenuis**, *Desor.*
15. **Lepralia annulata**, *Johnst.*
16. **Lepralia sordida**, *Stm.*
17. **Lepralia rubens**, *Stm.*
18. **Lepralia crassispina**, *Stm.*
19. **Lepralia labiata**, *Stm.*
20. **Hippothoa rugosa**, *Stm.*
21. **Gemellaria dumosa**, *Stm.*
22. **Crisia denticulata**, *Johnst.*
23. **Crisia cribraria**, *Stm.*
24. **Idmonea pruinosa**, *Stm.*
25. **Tubulipora divisa**, *Stm.*
26. **Tubulipora patina**, *Johnst.*
27. **Tubulipora crates**, *Stm.*

TUNICATA.

28. **Botryllus stellatus**, *Pallas.*
29. **Synoicum turgens**, *Phipps.*
30. **Salpa Caboti**, *Desor.*
31. **Boltenia clavata**, *O. Fabr.*
32. **Boltenia rubra**, *Stm.*
33. **Pera pellucida**, *Stm.*
34. **Cynthia crystallina**, *Möll.*
35. **Cynthia pyriformis**, *Rathke.*
36. **Cynthia subcaerulea**, *Stm.*
37. **Cynthia partita**, *Stm.*

38. Cynthia vittata, *Stm.*
39. Cynthia echinata, *Lin.*
40. Cynthia complanata, *O. Fabr.*
41. Cynthia gutta, *Stm.*
42. Cynthia monocera, *Möll.*
43. Cynthia conchilega, *Müll.*
44. Glandula glutinans, *Möll.*
45. Glandula mollis, *Stm.*
46. Glandula fibrosa, *Stm.*
47. Molgula arenata, *Stm.*
48. Molgula sordida, *Stm.*
49. Molgula producta, *Stm.*
50. Ascidia manhattensis, *DeKay.*
51. Ascidia tenella, *Stm.*
52. Ascidia lurida, *Möll.*
53. Ascidia callosa, *Stm.*
54. Chelysoma Macleayana, *Br. & [Sow.*
55. Chelysoma geometrica, *Stm.*
56. Pelonaia arenifera, *Stm.*

PALLIOBRANCHIATA.

57. Lingula pyramidata, *Stm.*
58. Rhynchonella psittacea, *Gm.*
59. Terebratella labradorensis, *Sow.*
60. Waldheimia cranium, *Müll.*
61. Terebratulina septentrionalis, *Couth.*

LAMELLIBRANCHIATA.

62. Anomia ephippium, *Lin.*
63. Anomia aculeata, *Gm.*
64. Ostrea virginiana, *Lister.*
65. Ostrea borealis, *Lam.*
66. Ostrea triangularis, *Holmes.*
67. Ostrea fundata, *Say.*
68. Ostrea equestris, *Say.*
69. Ostrea semicylindrica, *Say.*
70. Plicatula barbadensis, *Petiv.*
71. Lima sulculus, *Leach.*
72. Lima scabra, *Born.*
73. Pecten tenuicostatus, *Migh.*
74. Pecten islandicus, *Ch.*
75. Pecten fuscus, *Gould.*
76. Pecten nodosus, *Lin.*
77. Pecten dislocatus, *Say.*
78. Pecten irradians, *Lam.*
79. Pecten groenlandicus, *Sow.*
80. Axinaea charlestonensis, *Holm.*
81. Arca Holmesii, *Kurtz.*
82. Arca pexata, *Say.*
83. Arca americana, *Gray.*
84. Arca caelata, *Con.*
85. Arca transversa, *Say.*
86. Arca glacialis, *Gray.*
87. Arca lienosa, *Say.*
88. Arca noae, *Lin.*
89. Arca ponderosa, *Say.*
90. Arca incongrua, *Say.*
91. Nucula inflata, *Hanc.*
92. Nucula expansa, *Reeve.*
93. Nucula tenuis, *Mont.*
94. Nucula delphinodonta, *Migh.*
95. Nucula proxima, *Say.*
96. Yoldia pygmaea, *Muenst.*
97. Yoldia arctica, *Gray.*
98. Yoldia sulcifera, *Reeve.*
99. Yoldia siliqua, *Reeve.*
100. Yoldia thraciformis, *Storer.*
101. Yoldia sapotilla, *Gould.*
102. Yoldia limatula, *Say.*
103. Yoldia myalis, *Couth.*
104. Leda buccata, *Möll.*
105. Leda tenuisulcata, *Couth.*
106. Leda minuta, *Müll.*
107. Leda acuta, *Con.*
108. Pinna squamosissima, *Phil.*
109. Pinna carolinensis, *Hanl.*
110. Avicula atlantica, *Lam.*
111. Lithophagus aristatus, *Sol.*
112. Dacrydium vitreum, *Möll.*
113. Crenella glandula, *Tott.*
114. Crenella pectinula, *Gould.*
115. Modiolaria nigra, *Gray.*
116. Modiolaria substriata, *Gray.*
117. Modiolaria laevigata, *Gray.*
118. Modiolaria discors, *Lin.*
119. Modiolaria corrugata, *Stm.*
120. Modiolaria lateralis, *Say.*
121. Modiola carolinensis, *Con.*
122. Modiola plicatula, *Lam.*
123. Modiola vulgaris, *Fleming.*
124. Modiola americana, *Leach.*
125. Modiola castanea, *Say.*
126. Mytilus edulis, *Lin.*
127. Mytilus cubitus, *Say.*
128. Dreissena leucopheata, *Con.*
129. Chama macrophylla, *Chemn.*
130. Chama arcinella, *Lin.*
131. Cardium elegantulum, *Möll.*
132. Cardium magnum, *Born.*
133. Cardium isocardia, *Lin.*
134. Cardium muricatum, *Lin.*
135. Cardium pinnulatum, *Con.*
136. Cardium islandicum, *Lin.*
137. Liocardium serratum, *Lin*
138. Liocardium Mortoni, *Con.*
139. Serripes groenlandicus, *Ch.*
140. Lucina contracta, *Say.*
141. Lucina crenulata, *Con.*
142. Lucina radians, *Con.*

143. **Lucina edentula**, *Lin.*
144. **Lucina filosa**, *Stm.*
145. **Lucina squamosa**, *Lam.*
146. **Lucina tigerina**, *Lin.*
147. **Lucina strigilla**, *Stm.*
148. **Cryptodon Gouldii**, *Phil.*
149. **Diplodonta ? punctata**, *Say.*
150. **Kellia planulata**, *Stm.*
151. **Turtonla minuta**, *O. Fabr.*
152. **Montacuta ferruginosa**, *Mont.*
153. **Montacuta elevata**, *Stm.*
154. **Lepton lepidum**, *Say.*
155. **Lepton fabagella**, *Con.*
156. **Lepton longipes**, *Stm.*
157. **Cyprina islandica**, *Lin.*
158. **Astarte Banksii**, *Leach.*
159. **Astarte striata**, *Leach.*
160. **Astarte semisulcata**, *Leach.*
161. **Astarte crebricostata**, *Forbes.*
162. **Astarte lactea**, *Br. & Sow.*
163. **Astarte compressa**, *Lin.*
164. **Astarte portlandica**, *Migh.*
165. **Astarte quadrans**, *Gould.*
166. **Astarte castanea**, *Say.*
167. **Astarte lunulata**, *Con.*
168. **Cardita borealis**, *Con.*
169. **Cardita tridentata**, *Say.*
170. **Cardita floridana**, *Con.*
171. **Mercenaria violacea**, *Schum.*
172. **Mercenaria Mortoni**, *Con.*
173. **Mercenaria notata**, *Say.*
174. **Gemma Tottenii**, *Stm.*
Venus gemma, Totten.
175. **Chione alveata**, *Con.*
176. **Chione cribraria**, *Con.*
177. **Chione cancellata**, *Lin.*
178. **Chione inaequalis**, *Say.*
179. **Chione trapezoidalis**, *Kurtz.*
180. **Callista gigantea**, *Chemn.*
181. **Callista maculata**, *Lin.*
182. **Callista convexa**, *Say.*
183. **Dosinia discus**, *Reeve.*
184. **Tapes fluctuosa**, *Gould.*
185. **Petricola pholadiformis**, *Lam.*
186. **Raëta canaliculata**, *Say.*
187. **Raëta lineata**, *Say.*
188. **Mactra oblonga**, *Say.*
189. **Mactra polynyma**, *Stm.*
M. ovalis, Gould.
190. **Mactra solidissima**, *Chemn.*
191. **Mactra similis**, *Say.*
192. **Mactra lateralis**, *Say.*
193. **Mactra nucleus**, *Con.*
194. **Ceronia arctata**, *Con.*
195. **Ceronia deaurata**, *Turt.*
196. **Donax fossor**, *Say.*
197. **Donax variabilis**, *Say.*
198. **Cumingia tellinoides**, *Con.*
199. **Semele orbiculata**, *Say.*
200. **Abra equalis**, *Say.*
201. **Tellina alternata**, *Say.*
202. **Tellina polita**, *Say.*
203. **Tellina tenera**, *Say*
204. **Tellina tenta**, *Say.*
205. **Tellina iris**, *Say.*
206. **Tellina brevifrons**, *Say.*
207. **Tellina elucens**, *Migh.*
208. **Tellina decora**, *Say.*
209. **Tellina lateralis**, *Say.*
210. **Tellina constricta**, *Brug.*
211. **Tellina lusoria**, *Say.*
212. **Strigilla flexuosa**, *Say.*
213. **Strigilla carnaria**, *Lin.*
214. **Macoma fusca**, *Say.*
215. **Macoma sabulosa**, *Spengl.*
216. **Macoma fragilis**, *O. Fabr.*
217. **Tellidora lunulata**, *Holmes.*
218. **Solen ensis**, *Lin.*
219. **Solen viridis**, *Say.*
220. **Machaera costata**, *Say.*
221. **Machaera squama**, *Blainv.*
222. **Siliquaria gibba**, *Spengl.*
223. **Siliquaria bidens**, *Chemn.*
224. **Solenomya velum**, *Say.*
225. **Solenomya borealis**, *Tott.*
226. **Mya truncata**, *Lin.*
227. **Mya arenaria**, *Lin.*
228. **Corbula contracta**, *Say*
229. **Neaera pellucida**, *Stm.*
230. **Cyrtodaria siliqua**, *Spengl.*
231. **Panopaea norvegica**, *Spengl.*
232. **Panopaea americana**, *Con.*
233. **Saxicava distorta**, *Say.*
234. **Saxicava arctica**, *Lin.*
235. **Anatina papyracea**, *Say.*
236. **Cochlodesma Leana**, *Con.*
237. **Thracia truncata**, *Migh.*
238. **Thracia myopsis**, *Möll.*
239. **Thracia Conradi**, *Couth.*
240. **Lyonsia arenosa**, *Möll*
241. **Lyonsia hyalina**, *Con.*
242. **Pandora trilineata**, *Say*
243. **Pholas costata**, *Lin.*
244. **Pholas truncata**, *Say.*
245. **Pholas oblongata**, *Say.*
246. **Pholas semicostata**, *Lea*
247. **Pholas crispata**, *Lin.*
248. **Pholadidea cuneiformis**, *Say*
249. **Xylotrya palmulata**, *Lam.*
250. **Teredo dilatata**, *Stm.*

GASTEROPODA.

PTEROPODA.

251. Clione limacina, *Phipps.*
252. Heterofusus balea, *Möll.*
253. Limacina helicina, *Phipps.*
254. Psyche globulosa, *Rang.*
255. Cleodora pyramidata, *Lin.*
256. Hyalea trispinosa, *Les.*

NUDIBRANCHIATA.

257. Limapontia zonata, *Grd.*
258. Placobranchus simplex, *Grd.*
259. Tergipes rupium, *Möll.*
260. Aeolis bostoniensis, *Couth.*
261. Aeolis farinacea, *Gould.*
262. Aeolis stellata, *Stm.*
263. Aeolis purpurea, *Stm.*
264. Aeolis diversa, *Couth.*
265. Aeolis gymnota, *Couth.*
266. Aeolis Olrikii, *Moerch.*
267. Aeolis salmonacea, *Couth.*
268. Aeolis mananensis, *Stm.*
269. Doto coronata, *Gmel.*
270. Dendronotus Reynoldsii, *Couth.*
271. Ancula sulphurea, *Stm.*
272. Proctaporia fusca, *O. Fabr.*
273. Polycera Holbollii, *Möll.*
274. Polycera illuminata, *Gould.*
275. Doris planulata, *Stm.*
276. Doris liturata, *Möll.*
277. Doris acutiuscula, *Stp.*
278. Doris obvelata, *Müll.*

OPISTHOBRANCHIATA.

279. Philine sinuata, *Stm.*
280. Philine quadrata, *Wood.*
281. Philine punctata, *Möll.*
282. Philine lineolata, *Couth.*
283. Scaphander puncto-striata, *M.*
284. Diaphana hiemalis, *Couth.*
285. Diaphana debilis, *Gould.*
286. Utriculus Gouldii, *Couth.*
287. Utriculus semen, *Reeve.*
288. Utriculus turritus, *Möll.*
289. Utriculus biplicatus, *Lea.*
290. Utriculus pertenuis, *Migh.*
291. Utriculus canaliculatus, *Say.*
292. Cylichna nucleola, *Reeve.*
293. Cylichna alba, *Brown.*
294. Cylichna oryza, *Tott.*
295. Bulla sculpta, *Reeve.*
296. Bulla incincta, *Migh.*
297. Bulla Reinhardtii, *Möll.*
298. Bulla solitaria, *Say.*
299. Tornatella puncto-striata, *C. B. Ad.*

PROSOBRANCHIATA.

300. Chiton mendicarius, *Migh.*
301. Chiton apiculatus, *Say.*
302. Chiton cinereus, *Lin.*
303. Chiton marmoreus, *O. Fabr.*
304. Chiton laevis, *Penn.*
305. Chiton albus, *Lin.*
306. Amicula Emersonii, *Couth.*
307. Entalis striolata, *Stm.*
308. Entalis pliocena, *T. & H.*
309. Tectura testudinalis, *Müll.*
310. Tectura alveus, *Con.*
311. Lepeta caeca, *Müll.*
312. Pilidium rubellum, *O. Fabr.*
313. Crepidula unguiformis, *Lam.*
314. Crepidula fornicata, *Lin.*
315. Crepidula convexa, *Say.*
316. Crepidula aculeata, *Gm.*
317. Crucibulum striatum, *Say.*
318. Cemoria noachina, *Lin.*
319. Fissurella alternata, *Say.*
320. Clypidella pustula, *Lin.*
321. Janthina fragilis, *Brug.*
322. Scissurella crispata, *Flem.*
323. Adeorbis costulata, *Möll.*
324. Margarita minutissima, *Migh.*
325. Margarita helicina, *O. Fabr.*
326. Margarita Vahlii, *Möll.*
327. Margarita argentata, *Gould.*
328. Margarita Harrisoni, *Hancock.*
329. Margarita obscura, *Couth.*
330. Margarita acuminata, *Migh.*
331. Margarita varicosa, *Migh.*
332. Margarita cinerea, *Couth.*
333. Margarita groenlandica, *Ch.*
334. Trochus occidentalis, *Migh.*
335. Turbo crenulatus, *Gm.*
336. Cochliolepis parasitica, *Stm.*
337. Skenea planorbis, *Fabr.*
338. Rissoella? eburnea, *Stm.*
339. Rissoella? sulcosa, *Migh.*
340. Rissoa minuta, *Tott.*
341. Rissoa robusta, *Lea.*
342. Rissoa turriculus, *Lea.*
343. Rissoa latior, *Migh.*
344. Rissoa aculeus, *Gould.*
345. Rissoa saxatilis, *Möll.*
346. Rissoa multilineata, *Stm.*
347. Rissoa Mighelsii, *Stm.*
348. Rissoa castanea, *Möll.*
349. Rissoa exarata, *Stm.*
350. Rissoa carinata, *Migh.*
351. Rissoa scrobiculata, *Möll.*
352. Lacuna vincta, *Mont.*
353. Lacuna glacialis, *Möll.*

354. Lacuna neritoidea, *Gould.*
355. Littorina litorea, *Lin.*
356. Littorina palliata, *Say.*
357. Littorina rudis, *Mont.*
358. Littorina irrorata, *Say.*
359. Scalaria Humphreysii, *Kien.*
360. Scalaria turbinata, *Con.*
361. Scalaria lineata, *Say.*
362. Scalaria multistriata, *Say.*
363. Scalaria novangliae, *Couth.*
364. Scalaria groenlandica, *Perry.*
365. Acirsa borealis, *Beck.*
366. Solarium granulatum, *Lam.*
367. Vermetus radicula, *Stm.*
368. Caecum pulchellum, *Stm.*
369. Turritella erosa, *Couth.*
370. Turritella reticulata, *Migh.*
371. Turritella costulata, *Migh.*
372. Turritella acicula, *Stm.*
373. Aporrhais occidentalis, *Beck.*
374. Bittium arcticum, *Moerch.*
375. Bittium nigrum, *Tott.*
376. Bittium Greenii, *C. B. Ad.*
377. Triforis nigrocinctus, *C. B. Ad.*
378. Odostomia producta, *C. B. Ad.*
379. Odostomia fusca, *C. B. Ad.*
380. Odostomia dealbata, *Stm.*
381. Odostomia modesta, *Stm.*
382. Odostomia bisuturalis, *Say.*
383. Odostomia trifida, *Tott.*
384. Odostomia seminuda, *C. B. Ad.*
385. Odostomia impressa, *Say.*
386. Turbonilla interrupta, *Tott.*
387. Turbonilla nivea, *Stm.*
388. Menestho albula, *Möll.*
389. Obeliscus crenulatus, *Holmes.*
390. Eulima conoidea, *K. & S.*
391. Eulima oleacea, *K. & S.*
392. Velutina zonata, *Gould.*
393. Velutina haliotoides, *Müll.*
394. Velutina lanigera, *Möll.*
395. Velutina flexilis, *Mont.*
396. Marsenina micromphala, *Bergh.*
397. Marsenina groenlandica, *M.*
398. Onchidiopsis groenlandica, *B.*
399. Catinus perspectivus, *Say.*
400. Natica pusilla, *Say.*
401. Natica clausa, *Sow.*
402. Lunatia heros, *Say.*
403. Lunatia triseriata, *Say.*
404. Lunatia Gouldii, *Phil.*
405. Lunatia groenlandica, *Möll.*
406. Mamma? immaculata, *Tott.*
407. Mamma? nana, *Möll.*
408. Neverita duplicata, *Say.*
409. Bulbus flavus, *Gould.*
410. Amauropsis helicoides, *Johnst.*
411. Amaura candida, *Möll.*
412. Volva uniplicata, *Sow.*
413. Marginella roscida, *Redf.*
414. Mitra groenlandica, *Möll.*
415. Voluta junonia, *Chemn.*
416. Pleurotoma plicata, *C. B. Ad.*
417. Pleurotoma cerina, *K. & S.*
418. Pleurotoma bicarinata, *Couth.*
419. Mangelia rubella, *K. & S.*
420. Mangelia filiformis, *Holmes.*
421. Bela exarata, *Möll.*
422. Bela nobilis, *Möll.*
423. Bela turricula, *Mont.*
424. Bela Woodiana, *Möll.*
425. Bela harpularia, *Couth.*
426. Bela violacea, *Migh.*
427. Bela livida, *Möll.*
428. Bela decussata, *Couth.*
429. Bela Pingelii, *Möll.*
430. Bela cancellata, *Migh.*
431. Bela pleurotomaria, *Couth.*
432. Bela Vahlii, *Möll.*
433. Bela elegans, *Möll.*
434. Oliva litterata, *Lam.*
435. Olivella mutica, *Say.*
436. Columbella ornata, *Rav.*
437. Columbella avara, *Say.*
438. Columbella rosacea, *Gould.*
439. Columbella lunata, *Say.*
440. Columbella dissimilis, *Stm.*
441. Dolium galea, *Lin.*
442. Semicassis granulosa, *Brug.*
443. Cassis cameo, *Stm.*
444. Pedicularia decussata, *Gould.*
445. Purpura lapillus, *Lin.*
446. Purpura floridana, *Con.*
447. Nassa obsoleta, *Say.*
448. Nassa trivittata, *Say.*
449. Nassa acuta, *Say.*
450. Nassa unicincta, *Say.*
451. Nassa vibex, *Say.*
452. Cerithiopsis terebralis, *C. B. A.*
453. Cerithiopsis Emersonii, *C. B. A.*
454. Acus dislocatus, *Say.*
455. Acus concavus, *Say.*
456. Buccinum undatum, *Lin.*
457. Buccinum cyaneum, *Brug.*
458. Buccinum ciliatum, *O. Fabr.*
459. Buccinum glaciale, *Lin.*
460. Buccinum Hancocki, *Moerch.*
461. Buccinum Donovani, *Gray.*
462. Buccinum undulatum, *Möll.*
463. Buccinum scalariforme, *Möll.*

464. Buccinum sericatum, *Hanc.*
465. Rapana? cinerea, *Say.*
466. Fusus norvegicus, *Chemn.*
467. Fusus pygmaeus, *Gould.*
468. Fusus pellucidus, *Hanc.*
469. Fusus propinquus, *Alder.*
470. Fusus Holbollii, *Möll.*
471. Fusus islandicus, *Chemn.*
472. Fusus ventricosus, *Gray.*
473. Fusus latericeus, *Möll.*
474. Fusus Kroyeri, *Möll.*
475. Fusus tornatus, *Gould.*
476. Fusus fornicatus, *O. Fabr.*
477. Fusus despectus, *Lin.*
478. Fusus decemcostatus, *Say.*
479. Trophon craticulatus, *O. Fabr.*
480. Trophon clathratus, *Lin.*
481. Trophon scalariformis, *Gould.*
482. Trophon Gunneri, *Loven.*
483. Sycotypus papyraceus, *Say.*
484. Busycon pyrum, *Dillw.*
485. Busycon canaliculatum, *Lin.*
486. Busycon carica, *Lin.*
487. Busycon perversum, *Lin.*
488. Trichotropis conica, *Möll.*
489. Trichotropis borealis, *B. & S.*
490. Admete viridula, *O. Fabr.*
491. Cancellaria reticulata, *Lin.*
492. Fasciolaria ligata, *Migh.*
493. Fasciolaria gigantea, *Kien.*
494. Fasciolaria tulipa, *Lin.*
495. Fasciolaria distans, *Lam.*
496. Ranella caudata, *Say.*
497. Murex spinicostata, *Val.*
498. Strombus alatus, *Gm.*

CEPHALOPODA.

499. Spirula fragilis, *Lam.*
500. Ommastrephes Bartramii, *Les.*
501. Onychia caribaea, *Les.*
502. Onychoteuthis Fabricii, *Möll.*
503. Onychoteuthis Bartlingii, *Les.*
504. Loligopsis pavo, *Les.*
505. Loligopsis hyperborea, *Stp.*
506. Sepiola atlantica, *D'Orb.*
507. Rossia palpebrosa, *Möll.*
508. Rossia Moelleri, *Stp.*
509. Loligo punctata, *DeKay.*
510. Loligo Pealei, *Les.*
511. Loligo brevipinna, *Les.*
512. Cirroteuthis Muellerii, *Esch.*
513. Octopus rugosus, *D'Orb.*
514. Octopus groenlandicus, *Dew.*

DOUBTFUL SPECIES.

515. Ascidia amphora, *Ag.*
516. Ascidia ocellata, *Ag.*
517. Arca improcera, *Con.*
518. Nucula radiata, *DeKay.*
519. Nucula cascoënsis, *Migh.*
520. Modiola pulex, *Lea.*
521. Modiola elliptica, *Lea.*
522. Modiola tulipa, *Lam.*
523. Modiola cicercula, *Möll.*
524. Mytilus faba, *O. Fabr.*
525. Lucina multistriata, *Con.*
526. Astarte Warhami, *Hanc.*
527. Venericardia cribraria, *Say.*
528. Cytherea occulta, *Say.*
529. Petricola dactylus, *Sow.*
530. Tellina tenuis, *Da Costa.*
531. Tellina versicolor, *Cozzens.*
532. Tellina maculosa, *Lam.*
533. Tellina mera, *Say.*
534. Doris pallida, *Ag.*
535. Dentalium occidentale, *Stm.*
536. Crepidula intorta, *Say.*
537. Crepidula acuta, *Lea.*
538. Infundibulum depressum, *Say*
539. Delphinula coarctata, *Migh.*
540. Margarita ornata, *DeKay.*
541. Margarita multilineata, *DeKay*
542. Cingula laevis, *DeKay.*
543. Cingula modesta, *Lea.*
544. Littorina lunata, *Lea.*
545. Turbo canaliculatus, *Say.*
546. Turritella areolata, *Stm.*
547. Turritella aequalis, *Say.*
548. Turritella alternata, *Say*
549. Chemnitzia spirata, *K. & S.*
550. Chemnitzia textilis, *Kurtz.*
551. Actaeon parvus, *Lea.*
552. Pasithea sordida, *Lea.*
553. Sigaretus maculatus, *Say.*
554. Cerithium cancellatum, *Lea.*
555. Columbella spizantha, *Rav.*
556. Columbella Gouldiana, *Ag.*
557. Buccinum Wheatleyi, *DeKay.*
558. Buccinum zonale, *Lins.*
559. Fusus Trumbulli, *Lins.*
560. Fusus muricatus, *Mont.*

[SECOND EDITION.]

CHECK LIST

OF THE

SHELLS OF NORTH AMERICA.

TERRESTRIAL GASTEROPODA.

BY

W. G. BINNEY

List No. 1. The species of the Pacific coast from the extreme north to Mazatlan.

No. 2. The species of Eastern North America, from the boreal regions to the Rio Grande.

No. 3. The species found in Mexico exclusive of those included in No. 1 (viz. 3, 7, 8, 11, 23, 25, 35, 37, 39, 40, 41, 42, 43, 45, 46, 47)

Section I.—PACIFIC COAST.

PULMONOBRANCHIATA.

Testacellidæ.

1. **Glandina Albersi**, *Pf.*
2. **Glandina turris**, *Pf.*

Arionidæ.

3. **Arion foliolatus**, *Gld.*

Heliciðæ.

4. **Limax columbianus**, *Gld.*
5. **Succinea cingulata**, *Forbes.*
6. **Succinea Nuttalliana**, *Lea.*
7. **Succinea oregonensis**, *Lea.*
8. **Succinea rusticana**, *Gld.*
9. **Helix acutedentata**, *W. G. B.*
10. **Helix anachoreta**, *W. G. B.*
11. **Helix areolata**, *Pf.*
12. **Helix areolata**, *Pf.* var. β. *Pf.*
13. **Helix areolata**, *Pf.* var. γ. *Pf.*
14. **Helix arrosa**, *Gld.*
15. **Helix aspersa** *Mull.?*
16. **Helix californiensis**, *Lea.*
17. **Helix columbiana**, *Lea.*
18. **Helix cultellata**, *Thomson.*
19. **Helix devia**, *Gld.*
20. **Helix Dupetithouarsi**, *Desh.*
21. **Helix exarata**, *Pf.*
22. **Helix fidelis**, *Gray.*
23. **Helix germana**, *Gld.*
24. **Helix infumata**, *Gld.*
25. **Helix intercisa**, *W. G. B.*
26. **Helix Kelletti**, *Forb.*
27. **Helix levis**, *Pf.*
28. **Helix levis**, *Pf.* var. β. *Pf.*
29. **Helix loricata**, *Gld.*, *Pf.*,
30. **Helix mazatlanica**, *Pf.*
31. **Helix mormonum**, *Pf.*

32. Helix Newberryana, *W. G. B.*
33. Helix Nickliniana, *Lea.*
34. Helix pandoræ, *Forb.*
35. Helix ramentosa, *Gld.*
36. Helix redemita, *W. G. B.*
37. Helix reticulata, *Pf.*
38. Helix sportella, *Gld.*
39. Helix strigosa, *Gld.*
40. Helix Townsendiana, *Lea.*
41. Helix tudiculata, *Binn.*
42. Helix vancouverensis, *Lea.*
43. Bulimus californicus, *Rve.*
44. Bulimus chordatus, *Pf.*
45. Bulimus excelsus, *Gld.*
46. Bulimus Humboldti, *Rve.*
47. Bulimus mexicanus, *Lam.*
48. Bulimus pallidior, *Sowb.*
49. Bulimus proteus, *Brod.*
50. Bulimus sufflatus, *Gld.*
51. Bulimus Ziegleri, *Pf.*
52. Orthalicus zebra, *Mull.*
53. Achatina californica, *Pf.*
54. Pupa Rowellii, *Newc.*

Onchidiidæ.

55. Onchidium Carpenteri, *W. G. B*

Auriculidæ.

56. Melampus olivaceus, *Cpr.*
57. Pedipes lirata, *W. G. B.*

Truncatellidæ.

58. Truncatella californica, *Pf.*

Section II.—EASTERN NORTH AMERICA.

PULMONOBRANCHIATA.

Testacellidæ.

59. Glandina bullata, *Gld.*
60. Glandina corneola, *W. G. B.*
61. Glandina parallela, *W. G. B.*
62. Glandina texasiana, *Pfr.*
63. Glandina truncata, *Gmel.*
64. Glandina Vanuxemensis, *Lea.*

Arionidæ.

65. Arion empiricorum, *Fer.?*
66. Arion hortensis, *Fer.*

Helicidæ.

67. Tebennophorus carolinensis, *Bosc.*
68. Tebennophorus dorsalis, *Binn.*
69. Limax agrestis, *Lin.*
70. Limax campestris, *Binn.*
71. Limax flavus, *Lin.*
72. Vitrina angelicæ, *Beck.*
73. Vitrina limpida, *Gld.*
74. Succinea aurea, *Lea.*
75. Succinea avara, *Say.*
76. Succinea avara, *Say.* var. major.
77. Succinea campestris, *Say.*
78. Succinea concordialis, *Gld.*
79. Succinea effusa, *Shutt.*
80. Succinea groenlandica, *Beck.*
81. Succinea Haydeni, *W. G. B.*
82. Succinea Haydeni, *W. G. B.* var. minor.
83. Succinea inflata, *Lea.*
84. Succinea lineata, *W. G. B.*
85. Succinea luteola, *Gld.*
86. Succinea obliqua, *Say.*
87. Succinea ovalis, *Gld. non Say.*
88. Succinea retusa, *Lea.*
89. Succinea Salleana, *Pf.*
90. Succinea Totteniana, *Lea.*
91. Succinea vermeta, *Say.*
92. Helix albolabris, *Say.*
93. Helix albolabris, *Say.* var. dentata.
94. Helix alternata, *Say.*
95. Helix appressa, *Say.*
96. Helix appressa, *Say.* var. a.
97. Helix arborea, *Say.*
98. Helix ariadnæ, *Pf.*
99. Helix aspersa, *Müll.*
100. Helix asteriscus, *Morse.*
101. Helix auriculata, *Say.*
102. Helix auriformis, *Bland.*
103. Helix avara, *Say.*
104. Helix barbigera, *Redf.*
105. Helix Berlandieriana, *Mor.*
106. Helix bucculenta, *Gld.*
107. Helix bucculenta, *Gld.* var. minor.
108. Helix bulbina, *Desh.*
109. Helix caduca, *Pf.*
110. Helix capsella, *Gld.*
111. Helix Carpenteriana, *Bland.*
112. Helix cellaria, *Mull.*
113. Helix cereolus, *Muhl.*
114. Helix chersina, *Say.*
115. Helix Christyi, *Bland.*
116. Helix Clarkii, *Lea.*

117. **Helix** clausa, *Say.*
118. **Helix** concava, *Say.*
119. **Helix** Cooperi, *W. G. B.*
120. **Helix** cumberlandiana, *Lea.*
121. **Helix** demissa, *Binn.*
122. **Helix** dentifera, *Binn.*
123. **Helix** divesta, *Gld.*
124. **Helix** Dorfeuilliana, *Lea.*
125. **Helix** Edgariana, *Lea.*
126. **Helix** Edvardsi, *Bld.*
127. **Helix** egena, *Say.*
128. **Helix** electrina, *Gld.*
129. **Helix** elevata, *Say.*
130. **Helix** Elliotti, *Redf.*
131. **Helix** espiloca, *Bland.*
132. **Helix** exigua, *Stim.*
133. **Helix** exoleta, *Binn.*
134. **Helix** Fabricii, *Beck.*
135. **Helix** fallax, *Say.*
136. **Helix** fatigiata, *Say.*
137. **Helix** friabilis, *W. G. B.*
138. **Helix** fuliginosa, *Binn.*
139. **Helix** griseola, *Pf.*
140. **Helix** gularis, *Say.*
141. **Helix** gularis, *Say.*
var. umbilicata.
142. **Helix** Gundlachi, *Pf.*
143. **Helix** Hazardi, *Bland.*
144. **Helix** Hindsi, *Pf.*
145. **Helix** hippocrepis, *Pf.*
146. **Helix** hirsuta, *Say.*
147. **Helix** hispida, *Linn.*
148. **Helix** hopetonensis, *Shut.*
149. **Helix** hortensis, *Mull.*
150. **Helix** incrustata, *Poey.*
151. **Helix** indentata, *Say.*
152. **Helix** indentata, *Say.*
var. umbilicata.
153. **Helix** inflecta, *Say.*
154. **Helix** inornata, *Say.*
155. **Helix** interna, *Say.*
156. **Helix** interna, *Say.*
var. albina.
157. **Helix** intertexta, *Binn.*
158. **Helix** intertexta, *Binn.*
var. carinata.
159. **Helix** introferens, *Bland.*
160. **Helix** jejuna, *Say.*
161. **Helix** kopnodes, *W. G. B.*
162. **Helix** labyrinthica, *Say.*
163. **Helix** lævigata, *Pf.*
164. **Helix** lasmodon, *Phill.*
165. **Helix** leporina, *Gld.*
166. **Helix** ligera, *Say.*
167. **Helix** limatula, *Ward.*
168. **Helix** lineata, *Say.*
169. **Helix** major, *Binn.*
170. **Helix** maxillata, *Gld.*
171. **Helix** milium, *Morse.*
172. **Helix** minuscula, *Binn.*
173. **Helix** minutissima, *Lea.*
174. **Helix** Mitchelliana, *Lea.*
175. **Helix** monodon, *Rack.*
176. **Helix** monodon, *Rack.*
var. 1. **Helix** fraterna, *Say.*
177. **Helix** monodon, *Rack.*
var. 2. **Helix** Leaii, *Ward.*
178. **Helix** Mooreana, *W. G. B.*
179. **Helix** mordax, *Shutt.*
180. **Helix** multidentata, *Binn.*
181. **Helix** multilineata, *Say.*
182. **Helix** multilineata, *Say.*
var. albina.
183. **Helix** multilineata, *Say.*
var. rufa, unicolor.
184. **Helix** nitida, *Mull.*
185. **Helix** obstricta, *Say.*
186. **Helix** oppilata, *Mor.*
187. **Helix** Ottonis, *Pf.*
188. **Helix** palliata, *Say.*
189. **Helix** palliata, *Say.*
var. carolinensis.
190. **Helix** pennsylvanica, *Green.*
191. **Helix** perspectiva, *Say*
192. **Helix** Postelliana, *Bld.*
183. **Helix** profunda, *Say.*
194. **Helix** pulchella, *Müll.*
195. **Helix** pulchella, *Müll.*
var. costata.
196. **Helix** pustula, *Fer.*
197. **Helix** pustuloides, *Bld.*
198. **Helix** Roemeri, *Pf.*
199. **Helix** Rugeli, *Shutt.*
200. **Helix** Sayii, *Binn.*
201. **Helix** sculptilis, *Bld.*
202. **Helix** septemvolva, *Say.*
203. **Helix** solitaria, *Say.*
204. **Helix** spinosa, *Lea.*
205. **Helix** Steenstrupii, *Mörch.*
206. **Helix** stenotrema, *Fer.*
207. **Helix** striatella, *Anth.*
208. **Helix** subplana, *Binn.*
209. **Helix** suppressa, *Say.*
210. **Helix** tenuistriata, *Binn.*
211. **Helix** texasiana, *Mor.*
212. **Helix** texasiana, *Mor.*
var. β, *Pf.*
213. **Helix** texasiana, *Mor.*
var. .
214. **Helix** tholus, *W. G. B.*

215. Helix thyroides, *Say.*
216. Helix tridentata, *Say.*
217. Helix Troostiana, *Lea.*
218. Helix uvulifera, *Shutt.*
219. Helix varians, *Menke.*
220. Helix ventrosula, *Pf.*
221. Helix vortex, *Pf.*
222. Helix vultuosa, *Gld.*
223. Helix Wheatleyi, *Bland.*
224. Bulimus acicula, *Müller.*
225. Bulimus alternatus, *Say.*
226. Bulimus dealbatus, *Say.*
227. Bulimus decollatus, *Lin.*
228. Bulimus Dormani, *W. G. B.*
229. Bulimus floridanus, *Pf.*
230. Bulimus Gossei, *Pf.*
231. Bulimus gracillimus, *Pf.*
232. Bulimus harpa, *Say.*
233. Bulimus marginatus, *Say.*
234. Bulimus Mariæ, *Albers.*
235. Bulimus modicus, *Gld.*
236. Bulimus multilineatus, *Say.*
237. Bulimus octona, *Ch.*
238. Bulimus patriarcha, *W. G. B.*
239. Bulimus Schiedeanus, *Pf.*
240. Bulimus Schiedeanus, *Pf.*
var. apice nigra.
241. Bulimus serperastrus, *Say.*
242. Bulimus subula, *Pf.*
243. Orthalicus undatus, *Brug.*
244. Orthalicus zebra, *Müll.*
245. Macroceramus Kieneri, *Pf.*
246. Achatina fasciata, *Müll.*
247. Achatina fasciata, *Müll.*
var. 1. Achatina crenata, *Sw.*
248. Achatina fasciata, *Müll.*
var. 2. Achatina solida, *Say.*
249. Achatina lubrica, *Müll.*
250. Achatina picta, *Rve.*
251. Pupa armifera, *Say.*
252. Pupa badia, *Ad.*
253. Pupa contracta, *Say.*
254. Pupa corticaria, *Say.*
255. Pupa decora, *Gld.*
256. Pupa Hoppii, *Möll.*
257. Pupa incana, *Binn.*
258. Pupa pellucida, *Pf.*
259. Pupa pentodon, *Say.*
260. Pupa placida, *Say.*
261. Pupa rupicola, *Say.*
262. Pupa variolosa, *Gld.*
263. Vertigo Gouldii, *Binn*
264. Vertigo milium, *Gld.*
265. Vertigo ovata, *Say.*
266. Vertigo simplex, *Gld.*
267. Cylindrella Goldfussi, *Menke*
268. Cylindrella jejuna, *Gld.*
269. Cylindrella Poeyana, *Orb.*
270. Cylindrella Rœmeri, *Pf.*

Veronicellidæ.

271. Veronicella floridana, *Binn.*

Auriculidæ.

272. Melampus bidentatus, *Say.*
273. Melampus cingulatus, *Pf.*
274. Melampus coffea, *Linn.*
275. Melampus flavus, *Gmel.*
276. Melampus floridanus, *Shutt.*
277. Melampus obliquus, *Say.*
278. Melampus pusillus, *Gmel.*
279. Melampus Redfieldi, *Pf.*
280. Alexia myosotis, *Drap.*
281. Blauneria pellucida, *Pf.*
282. Leuconia Sayii, *Küst.*
283. Carychium exiguum, *Say.*

Truncatellidæ.

284. Truncatella bilabiata, *Pf.*
285. Truncatella caribæensis, *Sowb*
286. Truncatella pulchella, *Pf.*
287. Truncatella subcylindrica, *Gr.*

Cyclophoridæ.

288. Ctenopoma rugulosum, *Pf.*
289. Chondropoma dentatum, *Say.*

Helicinidæ.

290. Helicina chrysocheila, *Binn.*
291. Helicina Hanleyana, *Pf.*
292. Helicina occulta, *Say.*
293. Helicina orbiculata, *Say.*
294. Helicina subglobulosa, *Poey.*
295. Helicina tropica, *Pf.*

Section III.—MEXICO.

PULMONOBRANCHIATA.

Testacellidæ.

296. Glandina candida, *Shuttl.*
297. Glandina carminensis, *Mor.*
298. Glandina conularis, *Pf.*
299. Glandina cordovana, *Pf.*
300. Glandina corneola, *W. G. B.*
301. Glandina delicatula, *Shuttl.*
302. Glandina Ghiesbreghti, *Pf.*
303. Glandina indusiata, *Pfr.*
304. Glandina isabellina, *Pf.*
305. Glandina Liebmanni, *Pf.*
306. Glandina margaritacea, *Pf.*
307. Glandina monilifera, *Pf.*
308. Glandina nana, *Shuttl.*
309. Glandina pulchella, *Pf.*
310. Glandina orizabæ, *Pf.*
311. Glandina solidula, *Pf.?*
312. Glandina Sowerbyana, *Pf.*
313. Glandina speciosa, *Pf.*
314. Glandina stigmatica, *Shuttl.*
315. Glandina Vanuxemensis, *Lea.*

Helicidæ.

316. Vitrina mexicana, *Beck.*
317. Simpulopsis chiapensis, *Pf.*
318. Simpulopsis cordovana, *Pf.*
319. Simpulopsis Salleana, *Pf.*
320. Succinea brevis, *Dunker.*
321. Succinea undulata, *Say.*
322. Helix ariadnæ, *Pf.*
323. Helix Berlandieriana, *Mor.*
324. Helix bicincta, *Pf.*
325. Helix bicruris, *Pf.*
326. Helix bilineata, *Pf.*
327. Helix caduca, *Pf.*
328. Helix chiapensis, *Pf.*
329. Helix coactiliata, *Fer.*
330. Helix contortuplicata, *Beck.*
331. Helix cordovana, *Pf.*
332. Helix Couloni, *Shuttl.*
333. Helix flavescens, *Wiegm.*
334. Helix fulvoidea, *Mor.*
335. Helix Ghiesbreghti, *Nyst.*
336. Helix griseola, *Pf.*
337. Helix Guillarmodi, *Shuttl.*
338. Helix helictomphala, *Pf.*
339. Helix Hindsi, *Pf.*
340. Helix Humboldtiana, *Val.*
341. Helix implicata, *Beck.*
342. Helix lucubrata, *Say.*
343. Helix mexicana, *Koch.*
344. Helix oajacensis, *Koch.*
345. Helix plagioglossa, *Pf.*
346. Helix Salleana, *Pf.*
347. Helix stolephora, *Val.*
348. Helix tenuicostata, *Dunk.*
349. Helix texasiana, *Mor.*
350. Helix trypanompala, *Pf.*
351. Helix veracruzensis, *Pf.*
352. Helix zonites, *Pf.*
353. Bulimus alternatus, *Say.*
354. Bulimus attenuatus, *Pf.*
355. Bulimus aurifluus, *Pf.*
356. Bulimus cordovanus, *Pf.*
357. Bulimus coriaceus, *Pf.*
358. Bulimus costatostriatus, *Pf.*
359. Bulimus Droueti, *Pf.*
360. Bulimus Dunkeri, *Pf.*
361. Bulimus emeus, *Say.*
362. Bulimus fenestratus, *Pf.*
363. Bulimus gnomon, *Beck.*
364. Bulimus Gruneri, *Pf.*
365. Bulimus Hegewischi, *Pf.*
366. Bulimus Humboldti, *Rve.*
367. Bulimus livescens, *Pf.*
368. Bulimus Mariæ, *Albers.*
369. Bulimus Martensi, *Pf.*
370. Bulimus mexicanus, *Lam.*
371. Bulimus patriarcha, *W. G. Binn*
372. Bulimus punctatissimus, *Less.*
373. Bulimus rudis, *Anton.*
374. Bulimus Schiedeanus, *Pf.*
375. Bulimus serperastrus, *Say.*
376. Bulimus sulcosus, *Pf.*
377. Bulimus sulphureus, *Pf.*
378. Bulimus truncatus, *Pf.*
379. Bulimus varicosus, *Pf.*
380. Spiraxis acus, *Shuttl.*
381. Spiraxis auriculacea, *Pf.*
382. Spiraxis biconica, *Pf.*
383. Spiraxis catenata, *Pf.*
384. Spiraxis coniformis, *Shuttl.*
385. Spiraxis dubia, *Pf.*
386. Spiraxis euptycta, *Pf.*
387. Spiraxis irrigua, *Shuttl.*
388. Spiraxis lurida, *Shuttl.*
389. Spiraxis mitræformis, *Shuttl.*
390. Spiraxis Nicoleti, *Shuttl.*

391. Spiraxis nigricans, *Pf.*
392. Spiraxis oblonga, *Pf.*
393. Spiraxis parvula, *Pf.*
394. Spiraxis Shuttleworthi, *Pf.*
395. Spiraxis streptostyla, *Pf.*
396. Spiraxis turgidula, *Pf.*
397. Orthalicus Boucardi, *Pf.*
398. Orthalicus livens, *Pf.*
399. Orthalicus longus, *Pf.*
400. Orthalicus undatus, *Brug.*
401. Achatina ambigua, *Pf.*
402. Achatina chiapensis, *Pf.*
403. Achatina Rangiana, *Pf.*
404. Achatina trochlea, *Pf.*
405. Achatina trypanodes, *Pf.*
406. Cylindrella apiostoma, *Pf.*
407. Cylindrella arctospira, *Pf.*
408. Cylindrella attenuata, *Pf.*
409. Cylindrella Boucardi, *Pf.*
410. Cylindrella clava, *Pf.*
411. Cylindrella cretacea, *Pf.*
412. Cylindrella decollata, *Nyst.*
413. Cylindrella denticulata, *Pf.*
414. Cylindrella filicosta, *Shuttl.*
415. Cylindrella Ghiesbreghti, *Pf.*
416. Cylindrella goniostoma, *Pf.*
417. Cylindrella grandis, *Pf.*
418. Cylindrella Liebmanni, *Pf.*
419. Cylindrella mexicana, *Pf.*
420. Cylindrella Pfeifferi, *Menke.*
421. Cylindrella Pilocerei, *Pf.*
422. Cylindrella polygyra, *Pf.*
423. Cylindrella splendida, *Pf.*
424. Cylindrella teres, *Menke.*
425. Cylindrella turris, *Pf.*

Auriculidæ.

426. Melampus coffea, *Linn.*

Truncatellidæ.

427. Truncatella caribæensis, *Sowb.*

Cyclophoridæ.

428. Cyclotus Dysoni, *Pf.*
429. Cyclophorus Boucardi, *Sallé.*
430. Cyclophorus mexicanus, *M.*
431. Tudora planospira, *Pf.*
432. Cistula trochlearis, *Pf.*
433. Chondropoma cordovanum, *P.*
434. Chondropoma truncatum, *W.*

Helicinidæ.

435. Helicina brevilabris, *Pf.*
436. Helicina chiapensis, *Pf.*
437. Helicina chrysocheila, *Binn.*
438. Helicina chrysocheila, *Shuttl.*
439. Helicina cinctella, *Shuttl.*
440. Helicina concentrica, *Pf.*
441. Helicina cordilleræ, *Sallé.*
442. Helicina delicatula, *Shuttl.*
443. Helicina elata, *Shuttl.*
444. Helicina flavida, *Menke.*
445. Helicina Ghiesbreghti, *Pf.*
446. Helicina Heloisæ, *Sallé.*
447. Helicina Lindeni, *Pf.*
448. Helicina lirata, *Pf.*
449. Helicina merdigera, *Sallé.*
450. Helicina notata, *Salle.*
451. Helicina Oweniana, *Pf.*
452. Helicina Sandozi, *Shuttl.*
453. Helicina sinuosa, *Pf.*
454. Helicina tenuis, *Pf.*
455. Helicina tropica, *Pf.*
456. Helicina turbinata, *Wiegm.*
457. Helicina zephyrina, *Ducl.*
458. Schasicheila alata, *Mke.*
459. Schasicheila Nicoleti, *Shuttl*
460. Schasicheila pannucea, *Mor.*

Proserpinidæ.

461. Ceres eolina, *Ducl.*
462. Ceres Salleana, *Gray.*

[SMITHSONIAN MISCELLANEOUS COLLECTIONS.]

CHECK LIST

OF THE

SHELLS OF NORTH AMERICA.

FLUVIATILE GASTEROPODA.

BY

W. G. BINNEY.

The species whose range is confined to Eastern North America are not indicated by any peculiar mark. The letter W. distinguishes those confined to the Pacific coast; the letters W. E. are affixed to the names of those found in both the Eastern and Western sections, while the Greenland and Mexican species are also respectively designated by the letters G. and M.

This list has been compiled from all American publications and the few European monographs treating of this branch of the Mollusca. I have preferred giving the name of many doubtful species rather than omit that of any which my own limited knowledge of the subject does not lead me to consider a synonym. The list, therefore, is not offered as a complete elimination of the synonymy, but rather as a temporary guide to the arrangement of this portion of the collection. It should not be quoted as authority.

PECTINIBRANCHIATA.

Melaniidæ.

1. Melania abbreviata, *Anth.*
2. Melania abrupta, *Lea.*
3. Melania abscida, *Anth.*
4. Melania acuta, *Lea.*
5. Melania acuto-carinata, *Lea.*
6. Melania adusta, *Anth.*
7. Melania æqualis, *Hald.*
8. Melania alexandrensis, *Lea.*
9. Melania altipeta, *Anth.*
10. Melania altilis, *Lea.*
11. Melania alveare, *Conr.*
12. Melania ambusta, *Anth.*
13. Melania ampla, *Anth.*
14. Melania angulata, *Anth.*
15. Melania angulosa, *Menke.*
16. Melania angustispira, *Anth.*
17. Melania annulifera, *Conr.*
18. Melania approximata, *Hald.*
19. Melania arachnoidea, *Anth.*
20. Melania arctata, *Lea.*
21. Melania armigera, *Say.*
22. Melania assimilis, *Lea.*
23. Melania athleta, *Anth.*
24. Melania auriculæformis, *Lea.*
25. Melania auriscalpium, *Menke.*
26. Melania Babylonica, *Lea.*
27. Melania baculum, *Anth.*
28. Melania basalis, *Lea.*
29. Melania bella, *Conr.*
30. Melania bellacrenata, *Hald.*
31. Melania bicincta, *Anth.*
32. Melania bicolorata, *Anth.*
33. Melania bicostata, *Anth.*
34. Melania bitæniata, *Conr.*
35. Melania bizonalis, *DeKay.*
36. Melania blanda, *Lea.*

37. Melania Boykiniana, *Lea.*
38. Melania brevis, *Lea.*
39. Melania brevispira, *Anth.*
40. Melania Brumbyi, *Lea.*
41. Melania brunnea, *Anth.*
42. Melania Buddii, *Lea.*
43. Melania bulbosa, *Gld.* W.
44. Melania caliginosa, *Lea.*
45. Melania canaliculata, *Say.*
46. Melania cancellata, *Say.*
47. Melania carinata, *Rav.*
48. Melania carinifera, *Lam.*
49. Melania carino-costata, *Lea.*
50. Melania casta, *Anth.*
51. Melania castanea, *Lea.*
52. Melania catenaria, *Say.*
53. Melania catenoides, *Lea.*
54. Melania circinata, *Lea.*
55. Melania clara, *Anth.*
56. Melania Clarkii, *Lea.*
57. Melania clavæformis, *Lea.*
58. Melania cœlatura, *Conr.*
59. Melania cognata, *Anth.*
60. Melania columella, *Lea.*
61. Melania comma, *Conr.*
62. Melania compacta, *Anth.*
63. Melania concinna, *Lea.*
64. Melania congesta, *Conr.*
65. Melania conica, *Say.*
66. Melania consanguinea, *Anth.*
67. Melania coracina, *Anth.*
68. Melania corneola, *Anth.*
69. Melania coronilla, *Anth.*
70. Melania corpulenta, *Anth.*
71. Melania costata, *Rav.*
72. Melania costifera, *Hald.*
73. Melania costulata, *Lea.*
74. Melania crebri-costata, *Lea.*
75. Melania crebri-striata, *Lea.*
76. Melania crenatella, *Lea.*
77. Melania cristata, *Anth.*
78. Melania cubicoides, *Anth.*
79. Melania Curreyana, *Lea.*
80. Melania curta, *Hald.*
81. Melania curvata, *Lea.*
82. Melania curvilabris, *Anth.*
83. Melania cuspidata, *Anth.*
84. Melania cylindracea, *Conr.*
85. Melania decora, *Lea.*
86. Melania decorata, *Anth.*
87. Melania depygis, *Say.*
88. Melania Deshayesiana, *Lea*
89. Melania densa, *Anth.*
90. Melania dislocata, *Rav.*
91. Melania dubiosa, *Lea.*
92. Melania Duttoniana, *Lea.*
93. Melania ebenum, *Lea.*
94. Melania Edgariana, *Lea*
95. Melania elata, *Anth.*
96. Melania elegantula, *Anth.*
97. Melania elevata, *Say.*
98. Melania eliminata, *Anth.*
99. Melania elongata, *Lea.*
100. Melania exarata, *Menke.*
101. Melania exarata, *Lea.*
102. Melania excavata, *Anth.*
103. Melania excurata, *Conr.*
104. Melania exigua, *Conr.* W.
105. Melania exilis, *Hald.*
106. Melania eximia, *Anth.*
107. Melania expansa, *Lea.*
108. Melania fastigiata, *Anth.*
109. Melania filum, *Lea.*
110. Melania Florentiana, *Lea.*
111. Melania Foremani, *Lea.*
112. Melania formosa, *Conr.*
113. Melania fuliginosa, *Lea.*
114. Melania funebralis, *Anth.*
115. Melania furva, *Lea.*
116. Melania fuscata, *Desh.*
117. Melania fusiformis, *Lea.*
118. Melania fusco-cincta, *Anth.*
119. Melania gemma, *DeKay.*
120. Melania germana, *Anth.*
121. Melania gibbosa, *Lea.*
122. Melania gibbosa, *Raf.*
123. Melania glabra, *Lea.*
124. Melania glandula, *Anth.*
125. Melania glauca, *Anth.*
126. Melania globula, *Lea.*
127. Melania gracilior, *Anth.*
128. Melania gracilis, *Lea.*
129. Melania gracillima, *Anth.*
130. Melania gradata, *Anth.*
131. Melania grata, *Anth.*
132. Melania gravida, *Anth.*
133. Melania grisea, *Anth.*
134. Melania Haleiana, *Lea.*
135. Melania harpa, *Lea.*
136. Melania hastata, *Anth.*
137. Melania Haysiana, *Lea*
138. Melania Hildrethiana, *Lea.*
139. Melania Holstonia, *Lea.*
140. Melania hybrida, *Anth.*
141. Melania Hydeii, *Conr.*
142. Melania imbricata, *Anth.*
143. Melania impressa, *Lea.*
144. Melania incrassata, *Anth.*
145. Melania inemta, *Anth.*
146. Melania inflata, *Hald.*

147. Melania inflata, *Lea.*
148. Melania infrafasciata, *Anth.*
149. Melania inornata, *Anth.*
150. Melania intersita, *Hald.*
151. Melania intertexta, *Anth.*
152. Melania iostoma, *Anth.*
153. Melania iota, *Anth.*
154. Melania Jayana, *Lea.*
155. Melania Kirtlandiana, *Lea.*
156. Melania læta, *Jay.*
157. Melania lævis, *Lea.*
158. Melania laqueata, *Say.*
159. Melania latitans, *Anth.*
160. Melania Lecontiana, *Lea.*
161. Melania Liebmanni, *Phil.* M.
162. Melania ligata, *Menke.*
163. Melania livescens, *Menke.*
164. Melania lugubris, *Lea.*
165. Melania marginata, *Raf.*
166. Melania Menkeana, *Lea.* W.
167. Melania modesta, *Lea.*
168. Melania monozonalis, *Lea.*
169. Melania multilineata, *Say.*
170. Melania napilla, *Anth.*
171. Melania nassula, *Conr.*
172. Melania nebulosa, *Conr.*
173. Melania neglecta, *Anth.*
174. Melania Newberryi, *Lea.* W.
175. Melania niagarensis, *Lea.*
176. Melania nigrocincta, *Anth.*
177. Melania nigrina, *Lea.* W.
178. Melania nitens, *Lea.*
179. Melania nobilis, *Lea.*
180. Melania nodulosa, *Lea.*
181. Melania nucleola, *Anth.*
182. Melania oblita, *Lea.*
183. Melania obtusa, *Lea.*
184. Melania occidentalis, *Lea.*
185. Melania occulta, *Anth.*
186. Melania Ocoensis, *Lea.*
187. Melania oliva, *Lea.*
188. Melania olivula, *Conr.*
189. Melania opaca, *Anth.*
190. Melania oppugnata *Lea.*
191. Melania Ordiana, *Lea.*
192. Melania ovalis, *Lea.*
193. Melania ovoidea, *Lea.*
194. Melania ovularis, *Menke.*
195. Melania pagodiformis, *Anth.*
196. Melania pallescens, *Lea.*
197. Melania pallidula, *Anth.*
198. Melania paucicosta, *Anth.*
199. Melania perangulata, *Conr.*
200. Melania percarinata, *Conr.*
201. Melania perfusca, *Lea.*
202. Melania pernodosa, *Lea.*
203. Melania perstriata, *Lea.*
204. Melania pilula, *Lea.*
205. Melania picta, *Lea.*
206. Melania pinguis, *Lea.*
207. Melania planogyra, *Anth.*
208. Melania planospira, *Anth.*
209. Melania plebeius, *Anth.*
210. Melania plena, *Anth.*
211. Melania plicifera, *Lea.* W.
212. Melania pluristriata, *Say.* M.
213. Melania ponderosa, *Anth.*
214. Melania Postellii, *Lea.*
215. Melania Potosiensis, *Lea.*
216. Melania prasinata, *Conr.*
217. Melania producta, *Lea.*
218. Melania proscissa, *Anth.*
219. Melania proteus, *Lea.*
220. Melania proxima, *Say.*
221. Melania pulchella, *Anth.*
222. Melania pulcherrima, *Anth.*
223. Melania pumila, *Lea.*
224. Melania pupoidea, *Anth.*
225. Melania pyramidalis, *Mor.* M
226. Melania pyrenella, *Conr.*
227. Melania regularis, *Lea.*
228. Melania rhombica, *Anth.*
229. Melania rigida, *Anth.*
230. Melania robulina, *Anth.*
231. Melania robusta, *Lea.*
232. Melania rubida, *Lea.* M.
233. Melania rufescens, *Lea.*
234. Melania rufula, *Hald.*
235. Melania rugosa, *Lea.*
236. Melania Saffordii, *Lea.*
237. Melania Schiedeana, *Phil.* M
238. Melania sculptilis, *Lea.*
239. Melania Sellersiana, *Lea.*
240. Melania semicarinata, *Say.*
241. Melania semicostata, *Conr.*
242. Melania shastaënsis, *Lea.* W.
243. Melania silicula, *Gld.* W
244. Melania simplex, *Say.*
245. Melania solida, *Lea.*
246. Melania sordida, *Lea.*
247. Melania spinalis, *Lea.*
248. Melania spurca, *Lea.*
249. Melania striatula, *Lea.*
250. Melania strigosa, *Lea.*
251. Melania stygia, *Say.*
252. Melania subangulata, *Anth.*
253. Melania subcylindracea, *Lea*
254. Melania subglobosa, *Say.*
255. Melania subsolida, *Lea.*
256. Melania substricta, *Hald.*

257. Melania subularis, *Lea.*
258. Melania succinulata, *Anth.*
259. Melania sulcosa, *Lea.*
260. Melania symmetrica, *Conr.*
261. Melania symmetrica, *Hald.*
262. Melania tabulata, *Anth.*
263. Melania tæniolata, *Anth.*
264. Melania Taitiana, *Lea.*
265. Melania tecta, *Anth.*
266. Melania tenebro-cincta, *Anth.*
267. Melania tenebrosa, *Lea.*
268. Melania terebralis, *Lea.*
269. Melania teres, *Lea.*
270. Melania textilosa, *Anth.*
271. Melania torquata, *Lea.*
272. Melania torta, *Lea.*
273. Melania torulosa, *Anth.*
274. Melania tracta, *Anth.*
275. Melania trochiformis, *Conr.*
276. Melania Troostiana, *Lea.*
277. Melania tuberculata, *Lea.*
278. Melania turgida, *Lea.*
279. Melania uncialis, *Hald.*
280. Melania undosa, *Anth.*
281. Melania undulata, *Say.*
282. Melania valida, *Anth.*
283. Melania Vanuxemensis, *Lea.*
284. Melania varicosa, *Ward.*
285. Melania venusta, *Lea.*
286. Melania versipellis, *Anth.*
287. Melania vestita, *Conr.*
288. Melania vicina, *Anth.*
289. Melania virens, *Anth.*
290. Melania virgata, *Lea.*
291. Melania virginica, *Gmel.*
292. Melania viridis, *Lea.*
293. Melania viridula, *Anth.*
294. Melania vittata, *Anth.*
295. Melania vittata, *Raf.*
296. Melania wahlamatensis, *L.* W.
297. Melania Warderiana, *Lea.* W.
298. Melania zonalis, *Raf.*
299. Lithasia geniculata, *Hald.*
300. Lithasia lima, *Conr.*
301. Lithasia nuclea, *Lea.*
302. Lithasia nupera, *Say.*
303. Lithasia salebrosa, *Conr.*
304. Lithasia Showalterii, *Lea.*
305. Gyrotoma alabamensis, *Lea.*
306. Gyrotoma ampla, *Anth.*
307. Gyrotoma babylonica, *Lea.*
308. Gyrotoma Buddii, *Lea.*
309. Gyrotoma bulbosa, *Anth.*
310. Gyrotoma carinifera, *Anth.*
311. Gyrotoma castanea, *Lea.*
312. Gyrotoma constricta, *Lea.*
313. Gyrotoma costata, *Shuttl.*
314. Gyrotoma curta, *Mighels.*
315. Gyrotoma cylindracea, *Müll.*
316. Gyrotoma demissa, *Anth.*
317. Gyrotoma excisa, *Lea.*
318. Gyrotoma funiculata, *Lea.*
319. Gyrotoma glandula, *Lea.*
320. Gyrotoma glans, *Lea.*
321. Gyrotoma globosa, *Lea.*
322. Gyrotoma Hartmanii, *Lea.*
323. Gyrotoma incisa, *Lea*
324. Gyrotoma laciniata, *Lea.*
325. Gyrotoma ovalis, *Anth.*
326. Gyrotoma ovoidea, *Shuttl.*
327. Gyrotoma pagoda, *Lea.*
328. Gyrotoma pumila, *Lea.*
329. Gyrotoma pyramidata, *Shuttl.*
330. Gyrotoma quadrata, *Anth.*
331. Gyrotoma recta, *Anth.*
332. Gyrotoma robusta, *Anth.*
333. Gyrotoma salebrosa, *Anth.*
334. Gyrotoma Showalterii, *Lea.*
335. Gyrotoma virens, *Lea.*
336. Gyrotoma wetumpkaensis, *L*
337. Leptoxis affinis, *Hald.*
338. Leptoxis altilis, *Lea.*
339. Leptoxis ampla, *Anth.*
340. Leptoxis angulata, *Conr.*
341. Leptoxis Anthonyi, *Redfield.*
342. Leptoxis carinata, *Anth.*
343. Leptoxis carinata, *DeKay*
344. Leptoxis carinata. *Lea.*
345. Leptoxis carinifera, *Anth.*
346. Leptoxis cincinnatiensis, *Lea*
347. Leptoxis contorta, *Lea.*
348. Leptoxis corpulenta, *Anth.*
349. Leptoxis costata, *Anth.*
350. Leptoxis crassa, *Hald.*
351. Leptoxis crenata, *Hald.*
352. Leptoxis dentata, *Couthouy.*
353. Leptoxis dentata, *Lea.*
354. Leptoxis dilatata, *Conr.*
355. Leptoxis dissimilis, *Say.*
356. Leptoxis elegans, *Anth.*
357. Leptoxis flammata, *Lea.*
358. Leptoxis formosa, *Lea.*
359. Leptoxis Foremani, *Lea.*
360. Leptoxis fusca, *Hald.* W.
361. Leptoxis gibbosa, *Lea.*
362. Leptoxis Griffithiana, *Lea.*
363. Leptoxis incisa, *Lea.*
364. Leptoxis inflata, *Lea.*
365. Leptoxis integra, *Say.*
366. Leptoxis isogona, *Say.*

367. Leptoxis ligata, *Anth.*
368. Leptoxis littorina, *Hald.*
369. Leptoxis melanoides, *Conr.*
370. Leptoxis monodontoides, *Con.*
371. Leptoxis Nickliniana, *Lea.*
372. Leptoxis nigrescens, *Conr.*
373. Leptoxis Nuttalliana, *Lea.* W.
374. Leptoxis obovata, *Say.*
375. Leptoxis ornata, *Anth.*
376. Leptoxis patula, *Anth.*
377. Leptoxis picta, *Conr.*
378. Leptoxis pisum, *Hald.*
379. Leptoxis plicata, *Conr.*
380. Leptoxis prærosa, *Say.*
381. Leptoxis pumila, *Conr.*
382. Leptoxis Rogersii, *Conr.*
383. Leptoxis rubiginosa, *Lea.*
384. Leptoxis solida, *Lea.*
385. Leptoxis Showalterii, *Lea.*
386. Leptoxis squalida, *Lea.*
387. Leptoxis subglobosa, *Say.*
388. Leptoxis tæniata, *Conr.*
389. Leptoxis trilineata, *Say.*
390. Leptoxis trivittata, *DeKay.*
391. Leptoxis Troostiana, *Lea.*
392. Leptoxis tuberculata, *Lea.*
393. Leptoxis turgida, *Hald.*
394. Leptoxis variabilis, *Lea.*
395. Leptoxis virens, *Lea.* W.
396. Leptoxis viridula, *Anth.*
397. Leptoxis vittata, *Lea.*
398. Leptoxis zebra, *Anth.*
399. Io brevis, *Anth.*
400. Io fluvialis, *Say.*
401. Io inermis, *Anth.*
402. Io spinosa, *Lea.*
403. Io spirostoma, *Anth.*
404. Io tenebrosa, *Lea.*
405. Io turrita, *Anth.*

Viviparidæ.

406. Vivipara acuta, *Raf.*
407. Vivipara alleghanensis, *Gr.*
408. Vivipara angulata, *Lea.*
409. Vivipara castanea, *Müll.* G.
410. Vivipara castanea, *Val.*
411. Vivipara coarctata, *Lea.*
412. Vivipara contorta, *Shuttl.*
413. Vivipara coosaensis, *Lea.*
414. Vivipara cornea, *Val.*
415. Vivipara cyclostomatiformis, *Lea.*
416. Vivipara decapitata, *Anth.*
417. Vivipara decisa, *Say.*
418. Vivipara Elliotti, *Lea.*
419. Vivipara exilis, *Anth.*
420. Vivipara genicula, *Conr.*
421. Vivipara georgiana, *Lea.*
422. Vivipara gonula, *Raf.*
423. Vivipara Haleiana, *Lea.*
424. Vivipara humerosa, *Anth.*
425. Vivipara incrassata, *Lea.*
426. Vivipara integra, *Say.*
427. Vivipara intertexta, *Say.*
428. Vivipara lacustris, *Raf.*
429. Vivipara lima, *Anth.*
430. Vivipara magnifica, *Conr.*
431. Vivipara microstoma, *Kirtl.*
432. Vivipara multicarinata, *Hald.* M
433. Vivipara nitida, *Rav.*
434. Vivipara plaioxis, *Raf.*
435. Vivipara ponderosa, *Say.*
436. Vivipara scalaris, *Jay.*
437. Vivipara regularis, *Lea.*
438. Vivipara rudis, *Rav.*
439. Vivipara rufa, *Hald.*
440. Vivipara rugosa, *Raf.*
441. Vivipara subcarinata, *Say.*
442. Vivipara subglobosa, *Say.*
443. Vivipara subpurpurea, *Say.*
444. Vivipara subsolida, *Anth.*
445. Vivipara sulculosa, *Menke.*
446. Vivipara transversa, *Say.*
447. Vivipara Troostiana, *Lea.*
448. Vivipara verrucosa, *Raf.*
449. Vivipara vivipara, *Lin.*
450. Vivipara Wareana, *Shuttl*
451. Bithinia nuclea, *Lea.* W.
452. Bithinia seminalis, *Hinds.* W.
453. Bithinia tentaculata, *Lin.* G.
454. Valvata humeralis, *Say.* M.
455. Valvata pupoidea, *Gld.*
456. Valvata sincera, *Say.* W. E.
457. Valvata tricarinata, *Say.*
458. Ampullaria depressa, *Say.*
459. Ampullaria flagellata, *Say.* M.
460. Ampullaria malleata, *Jonas.* M.
461. Ampullaria paludinoides, *De Crist. et Jan.* M.
462. Ampullaria reflexa, *Sw.* M.
463. Ampullaria scalaris, *D'Orb.* M.
464. Ampullaria urceus, *Linn.?* M.
465. Ampullaria violacea, *Val.* M.
466. Amnicola attenuata, *Hald.*
467. Amnicola cincinnatensis, *A.*
468. Amnicola decisa, *Hald.*
469. Amnicola elongata, *Jay.*
470. Amnicola galbana, *Hald.*

471. Amnicola granum, *Say*.
472. Amnicola lapidaria, *Say*.
473. Amnicola limosa, *Say*.
474. Amnicola longinqua, *Gld*. W.
475. Amnicola lustrica, *Say*.
476. Amnicola Nickliniana, *Lea*.
477. Amnicola obtusa, *Lea*.
478. Amnicola orbiculata, *Lea*.
479. Amnicola pallida, *Hald*.
480. Amnicola parva, *Lea*.
481. Amnicola porata, *Say*.
482. Amnicola protea, *Gld*. W.
483. Amnicola tenuipes, *Couper*.
484. Amnicola Sayana, *Anth*.

PULMONOBRANCHIATA.

Limnæidæ.

485. Limnæa ampla, *Mighels*.
486. Limnæa apicina, *Lea*. W.
487. Limnæa appressa, *Say*.
488. Limnæa attenuata, *Say*. M.
489. Limnæa bulimoides, *Lea*. W.
490. Limnæa caperata, *Say*.
491. Limnæa casta, *Lea*.
492. Limnæa catascopium, *Say*. W. E.
493. Limnæa coarctata, *Lea*.
494. Limnæa columella, *Say*.
495. Limnæa curta, *Lea*.
496. Limnæa decollata, *Mighels*.
497. Limnæa desidiosa, *Say*.
498. Limnæa exigua, *Lea*. W. E.
499. Limnæa expansa, *Hald*.
500. Limnæa ferruginea, *Hald*. W.
501. Limnæa fusiformis, *Lea*.
502. Limnæa galbana, *Say*.
503. Limnæa gracilis, *Jay*.
504. Limnæa grœnlandica, *Beck*. G.
505. Limnæa Griffithiana, *Lea*.
506. Limnæa Haydeni, *Lea*.
507. Limnæa Holbollii, *Beck*. G.
508. Limnæa humilis, *Say*.
509. Limnæa jugularis, *Say*. W. E.
510. Limnæa Kirtlandiana, *Lea*.
511. Limnæa lanceata, *Gld*.
512. Limnæa lepida, *Gld*. W.
513. Limnæa megasoma, *Say*.
514. Limnæa obrussa, *Say*.
515. Limnæa pallida, *Ad*. W. E.
516. Limnæa palustris, *Lin*. W. E.
517. Limnæa parva, *Lea*.
518. Limnæa Pingelii, *Beck*. G.
519. Limnæa planulata, *Lea*.
520. Limnæa platyostoma, *Hald*.
521. Limnæa plica, *Lea*.
522. Limnæa proxima, *Lea*. W
523. Limnæa reflexa, *Say*.
524. Limnæa rugosa, *Val*. M.
525. Limnæa rustica, *Lea*.
526. Limnæa solida, *Lea*. W.
527. Limnæa strigosa, *Lea*.
528. Limnæa subulata, *Dunk*. M.
529. Limnæa Vahlii, *Beck*. G.
530. Limnæa vitrea, *Hald*.
531. Pompholyx effusa, *Lea*. W.
532. Physa ancillaria; *Say*.
533. Physa aurantia, *Carp*. W.
534. Physa bullata, *Gld*. W.
535. Physa Charpentieri, *Küst*.
536. Physa concolor, *Hald*. W.
537. Physa distorta, *Hald*.
538. Physa elata, *Gld*. W.
539. Physa fragilis, *Mighels*.
540. Physa globosa, *Hald*.
541. Physa gyrina, *Say*.
542. Physa heterostropha, *Say*. W. E
543. Physa Hildrethiana, *Lea*.
544. Physa humerosa, *Gld*. W.
545. Physa hypnorum, *Lin*. W. E
546. Physa inflata, *Lea*.
547. Physa integra, *Hald*.
548. Physa mexicana, *Phil*. M.
549. Physa microstoma, *Hald*.
550. Physa nitens, *Phil*. M.
551. Physa osculans, *Hald*. M.
552. Physa Philippii, *Küster*.
553. Physa pomilia, *Conr*.
554. Physa semiplicata, *Küst*. ?
555. Physa scalaris, *Jay*.
556. Physa solida, *Phil*.
557. Physa triticea, *Lea*.
558. Physa Troostiana, *Lea*.
559. Physa vinosa, *Gld*.
560. Physa virgata, *Gld*. W.
561. Physa virginea, *Gld*. W.
562. Planorbis albus, *Müll*.
563. Planorbis ammon, *Gld*. W.
564. Planorbis antrorsus, *Conr*.
565. Planorbis arcticus, *Beck*. G.
566. Planorbis armigerus, *Say*.
567. Planorbis bellus, *Lea*.
568. Planorbis bicarinatus, *Say*.
569. Planorbis Buchanensis, *Lea*.
570. Planorbis campanulatus, *Say*.
571. Planorbis corpulentus, *Say*. W. E
572. Planorbis deflectus, *Say*.
573. Planorbis dilatatus, *Gld*.
574. Planorbis exacutus, *Say*.

575. Planorbis fragilis, *Dunk.* M.
576. Planorbis glabratus, *Say.* W. E.
577. Planorbis gracilentus, *Gld.* W.
578. Planorbis Haldemani, *D.* M.
579. Planorbis lentus, *Say.*
580. Planorbis Liebmanni, *D.* M
581. Planorbis multivolvis, *Case.*
582. Planorbis Newberryi, *Lea.* W.
583. Planorbis obtusus, *Lea.*
584. Planorbis opercularis, *Gld.* W.
585. Planorbis planulatus, *Cooper.* W.
586. Planorbis parvus, *Say.*
587. Planorbis regularis, *Lea.*
588. Planorbis subcrenatus, *Carp.* W.
589. Planorbis tenuis, *Phil.* M.
590. Planorbis Traskii, *Lea.* W.
591. Planorbis trivolvis, *Say.* W. E.
592. Planorbis trivolvis, *Say.* var. fallax.
593. Planorbis tumens, *Carp.* W.
594. Planorbis tumidus, *Pf.* M.
595. Planorbis vermicularis, *Gld.* W
596. Planorbis Wheatleyi, *Lea.*
597. Ancylus calcarius, *DeKay.*
598. Ancylus crassus, *Hald.* W.
599. Ancylus depressus, *Hald*
600. Ancylus diaphanus, *Hald.*
601. Ancylus elatior, *Anth.*
602. Ancylus filosus, *Conr.*
603. Ancylus fuscus, *Adams.*
604. Ancylus Newberryi, *Lea.* W.
605. Ancylus Nuttalli, *Hald.* W.
606. Ancylus obscurus, *Hald.*
607. Ancylus parallelus, *Hald.*
608. Ancylus patelloides, *Lea.* W
709. Ancylus rivularis, *Say.*
610. Ancylus tardus, *Say.*

CHECK LIST

OF THE

SHELLS OF NORTH AMERICA.

CYCLADES.

BY

TEMPLE PRIME.

[NOTE.—In the following list the species not marked are found living in the United States. F. signifies that they are found fossil. C. refers to Cuba; C. A. to Central America; H. to Honduras; J. to Jamaica; M. to Mexico; P. to Panama; Y. to Yucatan.]

1. **Pisidium abditum**, *Hald.*
2. **Pisidium Adamsi**, *Pr.*
3. **Pisidium æquilaterale**, *Pr.*
4. **Pisidium arcuatum**, *Pr.* **F.**
5. **Pisidium compressum**, *Pr.*
6. **Pisidium contortum**, *Pr.* **F.**
7. **Pisidium ferrugineum**, *Pr.*
8. **Pisidium novi-eboraci**, *Pr.*
9. **Pisidium retusum**, *Pr.* **H.**
10. **Pisidium rotundatum**, *Pr.*
11. **Pisidium tenellum**, *Gould.*
12. **Pisidium variabile**, *Pr.*
13. **Pisidium ventricosum**, *Pr.*
14. **Pisidium virginicum**, *Bgt.*

15. **Sphærium acuminatum**, *Pr.*
16. **Sphærium aureum**, *Pr.*
17. **Sphærium bulbosum**, *Anth.*
18. **Sphærium cardissum**, *Pr.*
19. **Sphærium dentatum**, *Hald.*
20. **Sphærium eburneum**, *Anth.*
21. **Sphærium elevatum**, *Hald.*
22. **Sphærium emarginatum**, *Pr.*
23. **Sphærium fabale**, *Pr.*
24. **Sphærium flavum**, *Pr.*
25. **Sphærium fuscatum**, *Rafin.*
26. **Sphærium gracile**, *Pr.*
27. **Sphærium Jayanum**, *Pr.*
28. **Sphærium maculatum**, *Mor.* **Y.**
29. **Sphærium nobile**, *Gould.*
30. **Sphærium occidentale**, *Pr.*
31. **Sphærium partumium**, *Say.*
32. **Sphærium patellum**, *Gould.*
33. **Sphærium pygmeum**, *Adams.* **J.**
34. **Sphærium rhomboideum**, *Say.*
35. **Sphærium rosaceum**, *Pr.*
36. **Sphærium securis**, *Pr.*
37. **Sphærium solidulum**, *Pr.*
38. **Sphærium sphæricum**, *Anth.*
39. **Sphærium stamineum**, *Conr.*
40. **Sphærium striatinum**, *Lam.*
41. **Sphærium subtransversum**, *Pr* **M**
42. **Sphærium sulcatum**, *Lam.*
43. **Sphærium tenue**, *Pr.*
44. **Sphærium tenuistriatum**, *Pr.*
45. **Sphærium transversum**, *Say.*
46. **Sphærium triangulare**, *Say.* **M**
47. **Sphærium truncatum**, *Lin.*
48. **Sphærium Veatleyii**, *Adams.* **J.**

49. **Cyrena californiensis**, *Pr.*
50. **Cyrena caroliniensis**, *Lam.*
51. **Cyrena cubensis**, *Pr.* **C.**
52. **Cyrena Cumingii**, *Desh.* **C. A.**
53. **Cyrena densata**, *Conr.* **F.**
54. **Cyrena floridana**, *Conr.*
55. **Cyrena insignis**, *Desh.*

56. Cyrena maritima, *Adams.* P.
57. Cyrena mexicana, *Sowb.*
58. Cyrena moreauensis, *Meek & Hayden.* F.
59. Cyrena nebraskensis, *Pr.* F.
60. Cyrena occidentalis, *Meek & Hayden.* F.
61. Cyrena olivacea, *Cpr.* C. A.
62. Cyrena panamensis, *Pr.* C. A.
63. Cyrena placens, *Hanley.* C. A.
64. Cyrena radiata, *Hanley.* C. A.
65. Cyrena salmacida, *Morelet.* C. A
66. Cyrena sordida, *Hanley.* C. A.

67. Corbicula convexa, *Desh.* C. A
68. Corbicula truncata, *Pr.* F.
69. Corbicula ventricosa, *Pr* M.

CHECK LIST

OF THE

SHELLS OF NORTH AMERICA.

UNIONIDÆ.

BY

ISAAC LEA.

NORTH AMERICA.

Unionidæ.

1. Unio abacus, *Hald.*
2. Unio abbevillensis, *Lea.*
3. Unio Aberti, *Con.*
4. Unio acutissimus, *Lea.*
5. Unio æquatus, *Lea.*
6. Unio Æsopus, *Green.*
7. Unio affinis, *Lea.*
8. Unio aheneus, *Lea.*
9. Unio alatus, *Say.*
10. Unio altilis, *Con.*
11. Unio amœnus, *Lea.*
12. Unio amygdalum, *Lea.*
13. Unio angustatus, *Lea.*
14. Unio anodontoides, *Lea.*
15. Unio apicinus, *Lea.*
16. Unio apiculatus, *Say.*
17. Unio approximus, *Lea.*
18. Unio aquilus, *Lea.*
19. Unio aratus, *Lea.*
20. Unio arcæformis, *Lea.*
21. Unio arctatus, *Con.*
22. Unio arctior, *Lea.*
23. Unio arcus, *Con.*
24. Unio argenteus, *Lea.*
25. Unio arquatus, *Con.*
26. Unio asper, *Lea.*
27. Unio asperrimus, *Lea.*
28. Unio atrocostatus, *Lea.*
29. Unio atromarginatus, *Lea.*
30. Unio aureus, *Lea.*
31. Unio Bairdii, *Lea.*
32. Unio Baldwinensis, *Lea.*
33. Unio Barrattii, *Lea.*
34. Unio Barnesianus, *Lea.*

34*a*. Unio Bradleianus, *Lea.*

35. Unio biangulatus, *Lea.*
36. Unio biemarginatus, *Lea.*
37. Unio bigbyensis, *Lea.*
38. Unio Binneyi, *Lea.*
39. Unio Blandianus, *Lea.*
40. Unio Blandingianus, *Lea.*
41. Unio Bournianus, *Lea.*
42. Unio Boydianus, *Lea.*
43. Unio Boykinianus, *Lea.*
44. Unio bracteacus, *Gould.*
45. Unio brevidens, *Lea.*
46. Unio Brumbyanus, *Lea.*
47. Unio Buckleyi, *Lea.*
48. Unio Buddianus, *Lea.*
49. Unio bulbosus, *Lea.*
50. Unio Burkensis, *Lea.*
51. Unio buxeus, *Lea.*
52. Unio cacao, *Lea.*
53. Unio cælatus, *Con.*
54. Unio caliginosus, *Lea.*
55. Unio callosus, *Lea.*
56. Unio camelopardilis, *Lea.*
57. Unio camelus, *Lea.*
58. Unio camptodon, *Say.*
59. Unio canadensis, *Lea.*
60. Unio capax, *Green.*
61. Unio caperatus, *Lea.*
62. Unio capsæformis, *Lea.*
63. Unio cariosus, *Say.*
64. Unio castaneus, *Lea.*
65. Unio castus, *Lea.*
66. Unio catawbensis, *Lea.*
67. Unio chattanoogaensis, *Lea.*
68. Unio clairbornensis, *Lea.*

69. Unio Clarkianus, *Lea.*
70. Unio clavus, *Lam.*
71. Unio cincinnatiensis, *Lea.*
72. Unio circulus, *Lea.*
73. Unio coccineus, *Lea.*
74. Unio collinus, *Con.*
75. Unio coloradoensis, *Lea.*
76. Unio compactus, *Lea.*
77. Unio compressus, *Lea.*
78. Unio compressissimus, *Lea.*
79. Unio complanatus, *Lea.*
80. Unio concavus, *Lea.*
81. Unio concestator, *Lea.*
82. Unio confertus, *Lea.*
83. Unio congaræus, *Lea.*
84. Unio Conradicus, *Lea.*
85. Unio constrictus, *Con.*
86. Unio contractus, *Lea.*
87. Unio contradens, *Lea.*
88. Unio Cooperianus, *Lea.*
89. Unio cor, *Con.*
90. Unio cornutus, *Bar.*
91. Unio coruscus, *Gould.*
92. Unio corvus, *Lea.*
93. Unio crassidens, *Lam.*
94. Unio creperus, *Lea.*
95. Unio crocatus, *Lea.*
96. Unio cumberlandianus, *Lea.*
97. Unio cuneolus, *Lea.*
98. Unio cuprinus, *Lea.*
99. Unio curtus, *Lea.*
100. Unio Cuvierianus, *Lea.*
101. Unio cylindricus, *Say.*
102. Unio cyrenoides, *Phili.*
103. Unio dactylus, *Lea.*
104. Unio dariensis, *Lea.*
105. Unio decisus, *Lea.*
106. Unio declivus, *Say.*
107. Unio decoratus, *Lea.*
108. Unio denigratus, *Lea.*
109. Unio discrepans, *Lea.*
110. Unio dispar, *Lea.*
111. Unio dolabriformis, *Lea.*
112. Unio dollabelloides, *Lea.*
112*a*. Unio dolosus. *Lea.*
113. Unio donaciformis, *Lea.*
114. Unio Dorfeuillianus, *Lea.*
115. Unio Downiei, *Lea.*
116. Unio dromas, *Lea.*
117. Unio Duttonianus, *Lea.*
118. Unio ebenus, *Lea.*
119. Unio Edgarianus, *Lea.*
120. Unio Eightsii, *Lea.*
121. Unio elegans *Lea.*
122. Unio Elliottii, *Lea.*
123. Unio ellipsis, *Lea.*
124. Unio Emmonsii, *Lea.*
125. Unio errans, *Lea.*
126. Unio Estabrookianus, *Lea.*
127. Unio exactus, *Lea.*
128. Unio excavatus, *Lea.*
129. Unio exiguus, *Lea.*
130. Unio extensus, *Lea.*
131. Unio fabalis, *Lea.*
132. Unio fallax, *Lea.*
133. Unio famelicus, *Gould.*
134. Unio fatuus, *Lea.*
135. Unio favosus, *Lea.*
136. Unio fibuloides, *Lea.*
137. Unio Fisherianus, *Lea.*
138. Unio flavescens, *Lea.*
139. Unio florentinus, *Lea.*
140. Unio floridensis, *Lea.*
141. Unio foliatus, *Hild.*
142. Unio folliculatus, *Lea.*
143. Unio Forbeseanus, *Lea.*
144. Unio Foremanianus, *Lea.*
145. Unio Forsheyi, *Lea.*
146. Unio fragosus, *Con.*
147. Unio fraternus, *Lea.*
148. Unio fucatus, *Lea.*
149. Unio fulgidus, *Lea.*
150. Unio fuliginosus, *Lea.*
151. Unio fulvus, *Lea.*
152. Unio fumatus, *Lea.*
153. Unio furvus, *Con.*
154. Unio fuscatus, *Lea.*
155. Unio Geddingsianus, *Lea.*
156. Unio geminus, *Lea.*
157. Unio Genthii, *Lea.*
158. Unio Georgianus, *Lea.*
159. Unio gibber, *Lea.*
160. Unio Gibbesianus, *Lea.*
161. Unio gibbosus, *Bar.*
162. Unio glaber, *Lea.*
163. Unio glans, *Lea.*
164. Unio globosus, *Lea.*
165. Unio Gouldii, *Lea.*
166. Unio gracilentus, *Lea.*
167. Unio gracilior, *Lea.*
168. Unio gracilis, *Barnes.*
169. Unio graniferus, *Lea.*
170. Unio Greenii, *Con.*
171. Unio Griffithianus, *Lea.*
172. Unio Haleianus, *Lea.*
173. Unio Hallenbeckii, *Lea.*
174. Unio Hanleyanus, *Lea.*
174*a*. Unio Hartmanianus, *Lea.*
175. Unio Haysianus, *Lea.*
176. Unio Hazlehurstianus, *Lea.*

177. Unio hebes, *Lea.*
178. Unio hebetatus, *Con.*
179. Unio Hembeli, *Con.*
180. Unio heterodon, *Lea.*
181. Unio Higginsii, *Lea.*
182. Unio hepaticus, *Lea.*
183. Unio hippopæus, *Lea.*
184. Unio holstinensis, *Lea.*
185. Unio hopetonensis, *Lea.*
186. Unio Houstonensis, *Lea.*
187. Unio hyalinus, *Lea.*
188. Unio Hydianus, *Lea.*
189. Unio incrassatus, *Lea.*
190. Unio ineptus, *Lea.*
191. Unio inflatus, *Lea.*
192. Unio infucatus, *Con.*
192*a*. Unio insulsus, *Lea.*
193. Unio intercedens, *Lea.*
194. Unio intermedius, *Con.*
195. Unio interruptus, *Lea.*
196. Unio inusitatis, *Lea.*
197. Unio iris, *Lea.*
198. Unio irroratus, *Lea.*
199. Unio Jamesianus, *Lea.*
200. Unio Jayensis, *Lea.*
201. Unio jejunus, *Lea.*
202. Unio Johannis, *Lea.*
203. Unio Jonesii, *Lea.*
204. Unio Kienerianus, *Lea.*
205. Unio Kirtlandianus, *Lea.*
206. Unio Kleinianus, *Lea.*
207. Unio lacrymosus, *Lea.*
208. Unio lævissimus, *Lea.*
209. Unio Lamarckianus, *Lea.*
210. Unio lanceolatus, *Lea.*
211. Unio latecostatus, *Lea.*
212. Unio latus, *Lea.*
213. Unio Lazarus, *Lea.*
214. Unio Lecontianus, *Lea.*
215. Unio lenior, *Lea.*
216. Unio lens, *Lea.*
217. Unio lepidus, *Gould.*
218. Unio Lesleyi, *Lea.*
219. Unio Lesueurianus, *Lea.*
220. Unio Lindsleyi, *Lea.*
221. Unio lineatus, *Lea.*
222. Unio lienosus, *Con.*
223. Unio ligamentinus, *Lam.*
224. Unio limatulus, *Con.*
225. Unio linguæformis, *Lea.*
226. Unio lugubris, *Lea.*
227. Unio luridus, *Lea.*
228. Unio luteolus, *Lam.*
229. Unio macer, *Lea.*
230. Unio maconensis, *Lea.*
231. Unio macrodon, *Lea.*
232. Unio maculatus, *Con.*
233. Unio Masoni, *Con.*
234. Unio Menkianus, *Lea.*
235. Unio Meredithii, *Lea.*
236. Unio merus, *Lea.*
237. Unio metanever, *Raf.*
238. Unio metastriatus, *Con.*
239. Unio micans, *Lea.*
240. Unio minor, *Lea.*
241. Unio mississippiensis, *Con.*
242. Unio modicellus, *Lea.*
243. Unio modicus, *Lea.*
244. Unio modioliformis, *Lea.*
245. Unio mœstus, *Lea.*
246. Unio monodontus, *Say.*
247. Unio Monroensis, *Lea.*
248. Unio Mooresianus, *Lea.*
249. Unio Moussonianus, *Lea.*
250. Unio Mühlfeldianus, *Lea.*
251. Unio multiplicatus, *Lea.*
252. Unio multiradiatus, *Lea.*
253. Unio mundus, *Léa.*
254. Unio mytiloides, *Raf.*
255. Unio nashvillianus, *Lea.*
256. Unio nasutus, *Say.*
257. Unio naviculoides, *Lea.*
258. Unio neglectus, *Lea.*
259. Unio Neislerii, *Lea.*
260. Unio neusensis, *Lea.*
261. Unio nigellus, *Lea.*
262. Unio nigerrimus, *Lea.*
263. Unio nigrinus, *Lea.*
264. Unio nitens, *Lea.*
265. Unio notatus, *Lea.*
266. Unio novi-enboraci, *Lea.*
267. Unio nucleopsis, *Con.*
268. Unio nux, *Lea.*
269. Unio obesus, *Lea.*
270. Unio obfuscus, *Lea.*
271. Unio obliquus, *Lam.*
272. Unio obnubilus, *Lea.*
273. Unio obscurus, *Lea.*
274. Unio obtusus, *Lea.*
275. Unio occidens, *Lea.*
276. Unio occidentalis, *Con.*
277. Unio occultus, *Lea.*
278. Unio ochraceus, *Say.*
279. Unio opacus, *Lea.*
280. Unio orbiculatus, *Hild.*
281. Unio oregonensis, *Lea.* **P.**
282. Unio ornatus, *Lea.*
283. Unio othcaloogensis, *Lea.*
284. Unio ovatus, *Say.*
285. Unio oviformis, *Con.*

286. Unio pallescens, *Lea.*
287. Unio palliatus, *Lea.*
288. Unio paludicolus, *Gould.*
289. Unio papyraceus, *Gould.*
289*a*. Unio parvulus, *Lea.*
290. Unio parvus, *Bar.*
291. Unio patulus, *Lea.*
292. Unio paulus, *Lea.*
293. Unio pectorosus, *Con.*
294. Unio pellucidus, *Lea.*
295. Unio penicillatus, *Lea.*
296. Unio penitus, *Con.*
297. Unio percoarctatus, *Lea.*
298. Unio perdix, *Lea.*
299. Unio permiscens, *Lea.*
300. Unio pernodosus, *Lea.*
301. Unio perovalis, *Con.*
302. Unio perovatus, *Con.*
303. Unio perpictus, *Lea.*
304. Unio perplexus, *Lea.*
305. Unio perplicatus, *Con.*
305*a*. Unio perpurpureus, *Lea.*
306. Unio perradiatus, *Lea.*
307. Unio personatus, *Say.*
308. Unio perstriatus, *Lea.*
309. Unio phaseolus, *Hild.*
310. Unio Phillipsii, *Con.*
311. Unio pictus, *Lea.*
312. Unio pilaris, *Lea.*
313. Unio pileus, *Lea.*
314. Unio pinguis, *Lea.*
315. Unio placitus, *Lea.*
315*a*. Unio plancus, *Lea.*
316. Unio planicostatus, *Lea.*
317. Unio Plantii, *Lea.*
318. Unio plenus, *Lea.*
319. Unio plicatus, *Lesueur.*
320. Unio pliciferus, *Lea.*
321. Unio Popeii, *Lea.*
322. Unio porrectus, *Con.*
323. Unio Postellii, *Lea.*
324. Unio Powellii, *Lea.*
325. Unio Prattii, *Lea.*
326. Unio Prevostianus, *Lea.*
327. Unio productus, *Con.*
328. Unio propinquus, *Lea.*
329. Unio proximus, *Lea.*
330. Unio pudicus, *Lea.*
331. Unio pulcher, *Lea.*
332. Unio pullatus, *Lea.*
333. Unio pullus, *Lea.*
334. Unio pulvinulus, *Lea.*
335. Unio pumilis, *Lea.*
336. Unio purpuratus, *Lam.*
337. Unio purpurellus, *Lea.*
338. Unio purpuriatus, *Say.*
339. Unio purus, *Lea.*
340. Unio pusillus, *Con.*
341. Unio pustulatus, *Lea.*
342. Unio pustulosus, *Lea.*
343. Unio Pybasii, *Lea.*
344. Unio pyramidatus, *Lea.*
345. Unio pyriformis, *Lea.*
346. Unio quadrans, *Lea.*
347. Unio quadratus, *Lea.*
348. Unio radians, *Lea.*
349. Unio radiatus, *Lam.*
350. Unio Raeensis, *Lea.*
351. Unio Rangianus, *Lea.*
352. Unio Ravenelianus, *Lea.*
353. Unio rectus, *Lam.*
354. Unio Reeveianus, *Lea.*
355. Unio regularis, *Lea.*
356. Unio retusus, *Lam.*
357. Unio Rhumphianus, *Lea.*
358. Unio roanokensis, *Lea.*
359. Unio rostriformis, *Lea.*
360. Unio Roswellensis, *Lea.*
361. Unio Rowellii, *Lea.*
362. Unio rubellinus, *Lea.*
363. Unio rufus, *Lea.*
364. Unio rufusculus, *Lea.*
365. Unio rotundatus, *Lam.*
366. Unio rubellus, *Con.*
367. Unio rubiginosus, *Lea.*
368. Unio rutersvillensis, *Lea.*
369. Unio rutilans, *Lea.*
370. Unio sagittiformis, *Lea.*
371. Unio salebrosus, *Lea.*
372. Unio satillaensis, *Lea.*
373. Unio satur, *Lea.*
374. Unio savannahensis, *Lea.*
375. Unio saxeus, *Con.*
376. Unio Schoolcraftensis, *Lea.*
377. Unio scitulus, *Lea.*
378. Unio securis, *Lea.*
379. Unio Shepardianus, *Lea.*
379*a*. Unio Showalterii, *Lea.*
380. Unio similis, *Lea.*
381. Unio simplex, *Lea.*
382. Unio simus, *Lea.*
383. Unio Sloatianus, *Lea.*
384. Unio solidus, *Lea.*
385. Unio sordidus, *Lea.*
386. Unio Sowerbianus, *Lea.*
387. Unio spadiceus, *Lea.*
388. Unio sparsus, *Lea.*
389. Unio spatulatus, *Lea.*
390. Unio spinosus, *Lea.*
391. Unio spissus, *Lea.*

392. **Unio splendidus**, *Lea.*
393. **Unio stagnalis**, *Con.*
394. **Unio stapes**, *Lea.*
395. **Unio Stewardsonii**, *Lea.*
396. **Unio Stonensis**, *Lea.*
397. **Unio stramineus**, *Con.*
398. **Unio striatulus**, *Lea.*
399. **Unio striatus**, *Lea.*
400. **Unio strigosus**, *Lea.*
401. **Unio subangulatus**, *Lea.*
402. **Unio subcrassus**, *Lea.*
403. **Unio subcroceus**, *Con.*
404. **Unio subellipsis**, *Lea.*
405. **Unio subflavus**, *Lea.*
406. **Unio subgibbosus**, *Lea.*
407. **Unio subinflatus**, *Con.*
408. **Unio sublatus**, *Lea.*
409. **Unio subniger**, *Lea.*
410. **Unio subovatus**, *Lea.*
411. **Unio subplanus**, *Lea.*
412. **Unio subrotundus**, *Lea.*
413. **Unio subtentus**, *Say.*
414. **Unio succissus**, *Lea.*
415. **Unio sudus**, *Lea.*
416. **Unio sulcatus**, *Lea.*
417. **Unio symmetricus**, *Lea.*
418. **Unio tæniatus**, *Con.*
419. **Unio Taitianus**, *Lea.*
420. **Unio Tappanianus**, *Lea.*
421. **Unio tenebricus**, *Lea.*
422. **Unio tener**, *Lea.*
423. **Unio tenerus**, *Rav.*
424. **Unio tennesseensis**, *Lea.*
425. **Unio tenuissimus**, *Lea.*
426. **Unio tetralasmus**, *Say.*
427. **Unio tetricus**, *Lea.*
428. **Unio texasensis**, *Lea.*
429. **Unio Thorntonii**, *Lea.*
430. **Unio tortivus**, *Lea.*
431. **Unio trapezoides**, *Lea.*
432. **Unio triangularis**, *Bar.*
433. **Unio trigonus**, *Lea.*
434. **Unio Troostensis**, *Lea.*
435. **Unio Troschelianus**, *Lea.*
436. **Unio trossulus**, *Lea.*
437. **Unio tuberculatus**, *Bar.*
438. **Unio tuberosus**, *Lea.*
439. **Unio tumescens**, *Lea.*
440. **Unio Tuomeyi**, *Lea.*
441. **Unio turgidulus**, *Lea.*
442. **Unio turgidus**, *Lea.*
443. **Unio umbrans**, *Lea.*
444. **Unio umbrosus**, *Lea.*
445. **Unio undulatus**, *Bar.*
446. **Unio unicolor**, *Lea.*
447. **Unio utriculus**, *Lea.*
448. **Unio Vanuxemensis**, *Lea.*
449. **Unio varicosus**, *Lea.*
450. **Unio Vaughanianus**, *Lea.*
451. **Unio velatus**, *Con.*
452. **Unio ventricosus**, *Bar.*
453. **Unio venustus**, *Lea.*
454. **Unio verrucosus**, *Bar.*
455. **Unio verutus**, *Lea.*
456. **Unio vibex**, *Con.*
457. **Unio vicinus**, *Lea.*
458. **Unio virens**, *Lea.*
459. **Unio virescens**, *Lea.*
460. **Unio viridans**, *Lea.*
461. **Unio viridicatus**, *Lea.*
462. **Unio viridiradiatus**, *Lea.*
463. **Unio watereensis**, *Lea.*
464. **Unio Whiteianus**, *Lea.*
465. **Unio Woodwardianus**, *Lea.*
466. **Unio Zeiglerianus**, *Lea.*
467. **Unio zigzag**, *Lea.*

468. **Margaritana arcula**, *Lea.*
469. **Margaritana calceola**, *Lea.*
470. **Margaritana complanata**, *Lea.*
471. **Margaritana confragosa**, *Lea.*
472. **Margaritana connasaugaensis** *Lea.*
473. **Margaritana Curreyana**, *Lea.*
474. **Margaritana dehiscens**, *Lea.*
475. **Margaritana deltoidea**, *Lea.*
476. **Margaritana Elliottii**, *Lea.*
477. **Margaritana elliptica**, *Lea.*
478. **Margaritana etowahensis**, *Con.*
479. **Margaritana fabula**, *Lea.*
480. **Margaritana georgiana**, *Lea.*
481. **Margaritana Gesnerii**, *Lea.*
482. **Margaritana Hildrethiana**, *Lea*
483. **Margaritana holstonia**, *Lea.*
484. **Margaritana margaritifera**, *Lea.* **A. & P.**
485. **Margaritana marginata**, *Lea.*
486. **Margaritana minor**, *Lea.*
486*a*. **Margaritana quadrata**, *Lea.*
487. **Margaritana radiata**, *Lea.*
488. **Margaritana Raveneliana**, *Lea.*
489. **Margaritana rugosa**, *Lea.*
490. **Margaritana Spillmanii**, *Lea.*
491. **Margaritana tombigbeensis**, *Lea.*
492. **Margaritana triangulata**, *Lea.*
493. **Margaritana undulata**, *Lea.*

494. **Anodonta angulata**, *Lea.*
495. **Anodonta argentea**, *Lea.*

496. **Anodonta arkansensis,** *Lea.*
497. **Anodonta Benedictii,** *Lea.*
498. **Anodonta Buchanensis,** *Lea.*
499. **Anodonta californiensis,** *Lea.* P.
500. **Anodonta Couperiana,** *Lea.*
501. **Anodonta cultrata,** *Gould.*
502. **Anodonta cylindracea,** *Lea.*
503. **Anodonta Danielsii,** *Lea.*
504. **Anodonta dariensis,** *Lea.*
505. **Anodonta decora,** *Lea.*
506. **Anodonta denigrata,** *Lea.*
507. **Anodonta Dunlapiana,** *Lea.*
508. **Anodonta edentula,** *Lea.*
509. **Anodonta fragilis,** *Lam.*
510. **Anodonta ferruginea,** *Lea.*
511. **Anodonta Ferussaciana,** *Lea.*
512. **Anodonta fluviatilis,** *Lea.*
513. **Anodonta Footiana,** *Lea.*
514. **Anodonta Gesnerii,** *Lea.*
515. **Anodonta gibbosa,** *Say.*
516. **Anodonta gigantea,** *Lea.*
517. **Anodonta grandis,** *Say.*
518. **Anodonta Hallenbeckii,** *Lea.*
519. **Anodonta harpethensis,** *Lea.*
520. **Anodonta horda,** *Gould.*
521. **Anodonta imbecillis,** *Say.*
522. **Anodonta implicata,** *Say.*
524. **Anodonta Kennerlyi,** *Lea.*
525. **Anodonta lacustris,** *Lea.*
526. **Anodonta Lewisii,** *Lea.*
527. **Anodonta Linnæana,** *Lea.*
528. **Anodonta lugubris,** *Say.*
529. **Anodonta Marryatana,** *Lea.*
530. **Anodonta modesta,** *Lea.*
531. **Anodonta Nuttalliana,** *Lea.* P
532. **Anodonta oblita,** *Lea.*
533. **Anodonta opaca,** *Lea.*
534. **Anodonta oregonensis,** *Lea.* P.
535. **Anodonta ovata,** *Lea.*
536. **Anodonta papyracea,** *Anth.*
537. **Anodonta pavonia,** *Lea.*
538. **Anodonta pepiniana,** *Lea.*
539. **Anodonta plana,** *Lea.*
540. **Anodonta plicata,** *Hald.*
541. **Anodonta salmonia,** *Lea.*
542. **Anodonta Shafferiana,** *Lea.*
542*a*. **Anodonta Showalterii,** *Lea.*
543. **Anodonta Stewartiana,** *Lea.*
544. **Anodonta subcylindracea,** *Lea.*
545. **Anodonta suborbiculata,** *Say.*
546. **Anodonta subvexa,** *Con.*
547. **Anodonta tetragona,** *Lea.*
548. **Anodonta texasensis,** *Lea.*
549. **Anodonta virens,** *Lea.*
550. **Anodonta virgulata,** *Lea.*
551. **Anodonta wahlamatensis,** *Lea.* P.
552. **Anodonta Wardiana,** *Lea.*

MEXICO AND CENTRAL AMERICA.

1. **Unio aratus,** *Lea.* Nicaragua.
2. **Unio Averyi,** *Lea.* Isth. Darien.
3. **Unio aztecorum,** *Phili.* Mexico.
4. **Unio Berlandierii,** *Lea.* Mexico.
5. **Unio Caldwellii,** *Lea.* Is. Darien.
5*a*. **Unio cognatus,** *Lea.*
5*b*. **Unio Couchianus,** *Lea.*
6. **Unio cuprinus,** *Lea.* Mexico.
7. **Unio cyrenoides,** *Phili.* Nicarag.
8. **Unio discus,** *Lea.* Mexico.
9. **Unio Dysonii,** *Lea.* Honduras.
10. **Unio goascoranensis,** *Lea.* Hon.
11. **Unio Liebmanni,** *Phili.* Mexico.
12. **Unio manubius,** *Gould.* Mexico.
13. **Unio medellinus,** *Lea.* Mexico.
14. **Unio mexicanus,** *Phili.* Mexico.
15. **Unio Newcombianus,** *Lea.* Nic.
16. **Unio Nicklinianus,** *Lea.* Mexico.
17. **Unio persulcatus,** *Lea.* Mexico.
18. **Unio petrinus,** *Gould.* Mexico.
19. **Unio pliciferus,** *Lea.* Mexico.
20. **Unio Poeyanus,** *Lea.* Mexico.
21. **Unio Rowellii,** *Lea.* Cent. Amer.
21*a*. **Unio Saladoensis,** *Lea.*
22. **Unio sapotalensis,** *Lea.* Mexico.
23. **Unio scamnatus,** *Morelet.* Cuba.
24. **Unio semigranosus,** *Vondem-Busch*, Mexico.
25. **Unio tabascoensis,** *Phili.* Mex.
26. **Unio tampicoensis,** *Lea.* Mex.
27. **Unio tecomatensis,** *Lea.* Mex.
28. **Unio umbrosus,** *Lea.* Mexico.

29. **Anodonta cylindracea,** *Lea.*
30. **Anodonta glauca,** *Valen.* Mex.
31. **Anodonta globosa,** *Lea.* Mex.
32. **Anodonta Henryana,** *Lea.* Mex.
33. **Anodonta Holtonis,** *Lea.* New Grenada.
34. **Anodonta luteola,** *Lea.* Is. Dar.
35. **Anodonta montezuma,** *Lea.* Central America.
36. **Anodonta nicaragua,** *Phili.* Nicaragua.

SMITHSONIAN MISCELLANEOUS COLLECTIONS.

DIRECTIONS

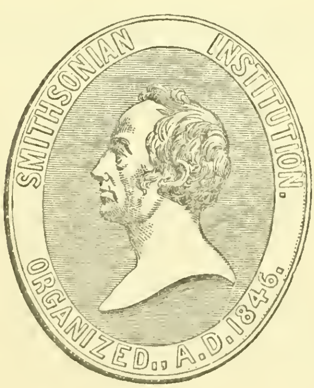
FOR

COLLECTING, PRESERVING, AND TRANSPORTING

SPECIMENS OF NATURAL HISTORY.

PREPARED FOR THE USE OF

THE SMITHSONIAN INSTITUTION.



[Third Edition.]

WASHINGTON:
SMITHSONIAN INSTITUTION.
MARCH, 1859.

CONTENTS.

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INTRODUCTION.

In the present pamphlet (prepared under the direction of Professor Baird with the co-operation of several naturalists) will be found brief directions for collecting and preserving objects of Natural History, drawn up for the use of travellers and others who may desire elementary instruction on this subject. The general principles involved are so simple as to enable any one, with but little practice, to preserve specimens sufficiently well for the ordinary purposes of science.

In transmitting specimens to the Smithsonian Institution, recourse may be had, when practicable, to the facilities kindly authorized by the War, Navy, and Treasury Departments, in the annexed letters. Parcels collected in the vicinity of military posts in the interior, may usually be sent down to the coast or the frontier in returning trains of the Quartermaster's Department. While waiting for opportunities of shipment, packages can generally be deposited in custom-houses, or public stores.

Where it is not convenient or practicable to make use of government facilities, the ordinary lines of transportation may be employed. When there is time enough to communicate with the Institution, instructions will be supplied as to the most eligible route; if not, then the cheapest but most reliable channel should be selected. In every case the parcels should be addressed to "the Smithsonian Institution, Washington," with the name of sender and locality marked on the outside. Full directions for packing specimens will be found in the pamphlet.

Collections in Natural History, as complete as possible, including the commonest species, are requested from any part of the country; as also lists and descriptions of species, notes of habits, &c.

For all assistance which may be rendered either in gathering specimens, or in aiding in their transportation, full credit will be given by the Institution in the annual reports to Congress, catalogues and labels of collections, and in other ways.

Joseph Henry,
Secretary Smithsonian Institution.

WAR DEPARTMENT,
Washington, January 17, 1852.

SIR: In reply to your letter of the 7th inst., asking whether authority can be given to the officers of the Quartermaster Department to receive and transmit specimens of Natural History for the use of the Smithsonian Institution, I have the honor to inform you that directions have been given through the Quartermaster-General to furnish the facilities you ask for, whenever it can be done without expense to the United States.

Very respectfully, your obedient servant,

C. M. CONRAD,
Secretary of War.

Prof. JOS. HENRY,
Secretary Smithsonian Institution.

NAVY DEPARTMENT,
February 21, 1853.

SIR: Authority is hereby given to you, to apply to the commanding officer of any vessel of war, or to any naval storekeeper of the United States, for facilities in transporting packages and specimens of Natural History intended for the Smithsonian Institution, and such officers are hereby required to furnish such facilities when asked for, provided they can be afforded without inconvenience to the public service and without expense to the United States.

I am, very respectfully, your obedient servant,

JOHN P. KENNEDY,
Secretary of the Navy.

Prof. J. HENRY,
Secretary Smithsonian Institution.

TREASURY DEPARTMENT,
January 25, 1854.

SIR: In reply to your communication of 13th inst., I have the honor to state that collectors of the customs, commanders of cutters, and other officers of this Department, are hereby authorized and required to receive into buildings or vessels under their control, any packages intended for the Smithsonian Institution, and to transport or transmit the same towards their destination, whenever this can be done without inconvenience to the public service and without expense to the United States.

I am, very respectfully, your obedient servant,

JAMES GUTHRIE,
Secretary of the Treasury.

Prof. JOSEPH HENRY,
Secretary Smithsonian Institution.

§ I. GENERAL REMARKS.*

THE general principle to be observed in making collections of Natural History, especially in a country but little explored, is to gather all the species which may present themselves, subject to the convenience or practicability of transportation. The number of specimens to be secured will, of course, depend upon their size, and the variety of form or condition caused by the different features of age, sex, or season.

As the object of the Institution in making its collections is not merely to possess the different species, but also to determine their geographical distribution, it becomes important to have as full series as practicable from each locality. And in commencing such collections, the commonest species should be secured first, as being most characteristic, and least likely to be found elsewhere. It is a fact well known in the history of museums, that the species which from their abundance would be first expected, are the last to be received.

In every little known region the species which are the commonest, are rarest elsewhere, and many an unscientific collector in Texas, Mexico, the Rocky Mts., and elsewhere, has been surprised to find what he considered the least valuable species in his collection (owing to the ease with which they had been obtained in numbers), more prized by the naturalist than the rarities, which were in fact only well known stragglers from more accessible localities.

The first specimen procured of any animal, however imperfect, should be preserved, at least until a better can be obtained.

Where a small proportion only of the specimens collected can be transported, such species should be selected as are least likely to be procured in other localities or on other occasions. Among these may be mentioned reptiles, fishes, soft insects, &c.; in short, all such as require alcohol for their preservation. Dried objects, as

* This chapter is intended especially for the guidance of travelling parties by land, and embraces many points referred to subsequently at greater length.

skins, can be procured with less difficulty, and are frequently collected by persons not specially interested in scientific pursuits.

In gathering specimens of any kind, it is important to fix with the utmost precision the localities where found. This is especially desirable in reference to fishes and other aquatic animals, as they occupy a very intimate relation to the waters in which they live.

The surest way of procuring the smaller mammals, as rats, mice, &c., is by setting traps in places where such animals may be expected to resort. A common mouse trap placed near the runs of meadow mice and baited with corn, potato, cheese, or other attractive substances, will often reveal the existence in numbers, of species whose presence was previously unknown. Corn shocks, stacks of hay, piles of rails, wood or stones, old stumps or logs, when overturned or removed, will often exhibit these mammals in greater or less number. They are also often turned up by the plough, spade, or pick.

Wolves, foxes, bears, and in fact most mammals can be obtained by placing strychnine on their favorite food.

There are two principal methods of preserving mammals; one by skinning, the other by throwing entire into alcohol. The skin, when removed from the body, as directed hereafter, may be prepared dry with arsenic, or placed in spirits; or if the animal be of small size, it may be thrown entire into alcohol, but an incision should *always* be made into the abdomen to facilitate the entrance of the liquid. The skin of the belly should also be separated from the subjacent walls of the abdomen. For purposes of examination it will be more convenient to have the skull removed entirely from the skin, when this is to be prepared dry; but care should be taken to attach corresponding marks to the two, so that they may be readily referred one to the other. The skull may then be preserved by boiling, or by cutting away the muscle, and drying, or by immersion in alcohol; in any case great care should be taken not to cut or mutilate any part of the bone, as its value would thereby be impaired. Separate skulls in any number, are always desirable. Where several specimens of a species are collected, the skulls of some may be left attached to the skin.

It will be well to preserve specimens of the smaller species, both as dry skins, and in alcohol.

It is very important to have the locality of specimens carefully noted and transmitted; and if possible, the date of capture,

and notes of habits and peculiarities. The sex, and color of the iris may likewise be indicated, and if not too much trouble, the following measurements in the case of skins of mammals: 1st, Length of head to the occiput; 2d, Length of head and body to the root of the tail; 3d, Length of tail from root to end of vertebræ, and 4th, Length of tail from root to the end of the hairs.

In many cases it is very difficult to preserve skins of the larger mammals, owing to the amount of arsenic required, the length of time needed for drying the specimens, or the inconveniently large bulk they occupy. All these objections may be readily obviated by the use of a fine powder composed of two parts of alum and one of saltpetre, intimately mixed.* Every portion of the fresh skin should be well covered with this mixture, to which some arsenic may be added, the powder being forced into every corner. It may be most readily applied by means of a tin dredging box and afterwards rubbed in. If the skin be perfectly fresh, it may be folded up, without any stuffing, shortly after application of the powder, and packed away; it will be better, however, to allow it to dry partially, although it should be folded up before losing its flexibility. The skin should always be taken, when possible, from a recently killed animal, and the preservative applied at once. Skins prepared in this way will relax sufficiently for mounting by soaking a few hours in cold water.

Any fat, blood or muscle, which may be attached to the skin, should be carefully removed before the preservative is applied, the surface being kept at the same time moist and fresh, in order that the powder may more readily adhere. The first coat may be applied when the skin is inverted, and the hair inside; it should, after a little while, be returned to its natural condition, and a second quantity of the powder added.

The skin should be folded up something like a coat, the hair side outward; the head, feet and tail, properly adjusted. In small specimens, the folding may be omitted, and the skin kept in a flattened state. In animals less than a fox, a little stuffing may be used to fill out the head, and a small portion placed in the skin and legs. As little, however, should be used as possible, as it is an important object to diminish in every way the bulk of the prepara-

* The use of this mixture was first suggested to the Smithsonian Institution by Mr. John G. Bell, of New York.

tion. No wrinkles, however, or unnecessary folds should be left in the skin.

In skinning the larger animals, the skull may generally be removed entirely, and thus the labor of preparation greatly reduced. In this case the skull can be cleaned separately, by boiling until the flesh becomes soft and easily removed, or the raw flesh may be cut away, the brain extracted, and the skull dried rapidly by exposure to the air and sun. It can at any time afterwards be cleaned more perfectly. The preservation of the skull is a matter of the highest importance.

Skins of large animals may readily be converted into pliable leather, by rubbing on salt, alum and soft soap, continuing the operation for a considerable length of time. When the skin becomes nearly dry, it should then be pounded or rubbed all over, until the desired softness is obtained.

The skeletons of all kinds of mammals, even of the commonest species, should be collected. These may be roughly prepared by cutting away the meat, and allowing the bones to dry in the air. The skeleton may be dismembered, and the ribs separated from the vertebræ. The bones of each leg should, however, be left attached to each other, if possible. The skull may be cleaned by boiling. Where there is an opportunity, it will be well to soak the bones in water for a few hours to remove the blood.

A perfectly dry skin will keep very well without any application of preservative material, provided the insects are excluded. To this end each specimen may be separately enveloped in paper. Tobacco leaves in layers between skins, and covering them, will be a sure protection against most adult insects; and in the absence of tobacco, any highly pungent or odoriferous substance, as the artemisia or sage, and larrea of the western plains, may be employed.

In preparing skins of any kind, it is a matter of prime importance not to use any animal substance, as wool, hair, or feathers, for stuffing.

Skins of mammals and birds, especially if at all greasy and not thoroughly freed from muscle, are very liable to the attacks of small beetles, as *Dermestes*, &c., when boxed up for any length of time, especially in the field, and valuable collections have frequently been entirely destroyed by them in less than a month. An occasional examination should therefore be made of such collections. Whenever possible, it will be well to envelop each speci-

men completely in paper or cotton-cloth. The greatest care should always be taken to keep from such collections any uncleaned skulls or bones, wool, hair, loose feathers, or unpreserved animal matter of any kind. If necessarily kept in the same boxes with skins, skulls, even if apparently quite clean, should be separately and closely wrapped up so as to prevent the access of insects to them. It must be borne in mind that it is the larvæ of these insects that do the mischief, and that a single female gaining access to a specimen may lay eggs enough to do a vast amount of injury when developed.

Where danger is apprehended to large skins, or where they have been already attacked, a quantity of arsenic may be boiled for a time in water, and after the free arsenic is strained out by means of a cloth, the liquid may be applied to the fur or wool by means of a watering-pot. The ears, lips, orbital region, and nose may be well moistened by an alcoholic solution of corrosive sublimate. A tincture of strychnine is said, however, to keep off insects much better than anything else. (See also page 22.)

In passing through the breeding grounds of birds, attention should be paid to securing abundant specimens of nests and eggs. When possible, the skin of the bird to which each set of eggs may belong should be secured. Further directions in regard to nests and eggs will be found hereafter. Skins of all the species of birds in each locality should be collected. A series of birds in alcohol will also be very desirable.

A great obstacle in the way of making alcoholic collections while on a march has been found in the escape of the spirits and the friction of the specimens, as well as in the mixing up of these from different localities. All such difficulties have been successfully obviated by means of the following arrangement: Instead of using glass jars, so liable to break, or even wooden kegs, so difficult of stowage, a square copper can should be procured, having a large mouth with a cap fitting tightly over it, either by a screw or otherwise. The can should be inclosed in a wooden box, or may be made to fit into a division of a leather pannier, to be slung across the back of a mule. Several small cans, in capacity of from a half to one-third of a cubic foot, or even less, will be better than one large one. Small bags of musquito netting, lino, crinoline, or other porous material, should be provided, made in shape like a pillow-case, and open at one end; these may be from six to fifteen inches

long. When small fishes, reptiles, or other specimens, are procured in any locality, they may be placed indiscriminately in one or more of these bags (the mouths of which are to be tied up like a sack or pinned over), and then thrown into the alcohol. Previously, however, a label of parchment, or stout writing paper should be placed inside the bag, containing the name of the locality or other mark, and written in ordinary ink or pencil. The label, if dry before being placed in the bag, will retain its writing unchanged for a long time. The locality, or its number, should also be coarsely marked with a red pencil, on the outside of the bag, or a second piece of numbered parchment pinned on. This, if dry when pinned, will swell so as to be in no danger of being lost off. In this way, the specimens, besides being readily identified, are preserved from rubbing against each other, and consequent injury. Still farther to facilitate this object, an India-rubber gas-bag may be employed to great advantage, by introducing it into the vessel, and inflating until all vacant space is filled up by the bag, and the consequent displacement of the spirit. When additional specimens are to be added, a portion of the air may be let out, and the bag afterwards again inflated. In the absence of these arrangements a quantity of tow, cotton, or rags, kept over the specimens, will be found useful in preventing their friction against each other or the sides of the vessel.

The tin cans with screw caps for preserving meats and vegetables from the atmosphere, and now so universally used, may be employed as a substitute for the copper tanks, as being cheaper and more easily obtained. The most useful sizes are a quart and half gallon. Care must, however, be taken not to crowd too many specimens in the cans, to have them full of alcohol, and to change the spirit at least once.

The larger snakes should be skinned, as indicated hereafter, and the skins thrown into alcohol. Much space will in this way be saved. Smaller specimens may be preserved entire, together with lizards, salamanders, and small frogs. All of these that can be caught should be secured and preserved. The head, the legs with the feet, the tail, in fact, the entire skin of turtles may be preserved in alcohol; the soft parts then extracted from the shell, which is to be washed and dried.

Reptiles are to be sought for in different localities: those covered with scales can generally be readily observed: the naked skinned

ones are generally more or less concealed. Tree frogs will be found in early spring by the side of small streams or ponds in the woods or meadows. Salamanders are found under logs or bark in damp woods, or under flat stones near or in the water.

Every stream, and, indeed, when possible, many localities in each stream, should be explored for fishes, which are to be preserved as directed. For these, as well as the other alcoholic collections, the lino bags are very useful.

The stomachs of fishes and other vertebrates will often be found to contain rare animals not otherwise procurable, and should be carefully examined.

Great attention should be paid to procuring many specimens of the different kinds of small fishes, usually known as minnows, shiners, chubs, &c. Among these will always be found the greatest variety of species, some never exceeding an inch in length. These fish are generally neglected under the idea that they are merely the young of larger kinds; even if they should prove to be such, however, they will be none the less interesting. Different forms will be found in different localities. Thus the *Etheostomata*, or Darters, and the *Cotti*, live under stones or among gravel, in shallow, clear streams, lying flat on the ground. Others will be dislodged by stirring under roots or shelving banks along the water's edge. The *Melanuræ*, or mud-fish (a few inches in length), dwell *in* the mud of ditches, and are secured by stirring up this mud into a thin paste with the feet, and then drawing a net through it. The sticklebacks and cyprinodonts live along the edges of fresh and salt water. The *Zygonectes* swim in pairs slowly along the surface of the water, the tip of the nose generally exposed. They generally have a broad black stripe on the side. By a careful attention to these hints, many localities supposed to be deficient in species of fishes will be found to yield a large number.

After the death of a mammal or bird, or after the skin has been prepared a short time, lice will be seen on the surface, generally near the head. These should be carefully preserved on small papers and marked, separately, with the name or number of the specimen to which they belong.

The alcohol used on a march may be supplied with tartar emetic. This, besides adding to its preservative power, will remove any temptation to drink it on the part of unscrupulous persons.

Insects, excepting the *Lepidoptera*, and those covered with hairs

or scales, can be readily preserved in alcohol. Small bottles should be used for the purpose. Crabs and small shells, and aquatic animals generally, may likewise be treated in the same manner.

It is not usually possible to collect minerals, fossils, and geological specimens in very great mass while travelling. The fossils selected should be as perfect as possible; and especial care should be paid to procuring the bones and teeth of vertebrate animals. Of minerals and rocks, specimens as large as a hickory-nut will, in many cases, be sufficient for identification.

Where collections cannot be made in any region, it will be very desirable to procure lists of all the known species, giving the names by which they are generally recognized, as well as the scientific name, when this is practicable. The common names of specimens procured should also be carefully recorded.

All facts relating to the habits and characteristics of the various species of animals, however trivial and commonplace they may seem, should be carefully recorded in the note book, especially those having relation to the peculiarities of the season of reproduction, &c. The accounts of hunters and others should also be collected, as much valuable information may thus be secured. The colors of the reptiles and fishes when alive should always be given, when practicable, or, still better, painted on a rough sketch of the object.

LIST OF APPARATUS USEFUL FOR TRAVELLING PARTIES.

1. TWO WOODEN CHESTS; OR TWO LEATHER PANNIERS supplied with back strap for throwing across a mule, when the transportation is entirely by pack animals. One of these is intended to contain the copper kettles, and their included alcohol, together with the nets and other apparatus; the other to hold the botanical apparatus, skins of animals, minerals, &c. These, when full, should not weigh more than one hundred and fifty pounds the pair. Where the transportation is by wagons, the kettles may be carried in stout wooden chests, about two feet long, one foot wide, and one foot high outside, made of inch stuff. Two half-inch partitions inside may cut off spaces at each end large enough to receive kettles six inches broad, leaving an intermediate space of nine inches for the accommodation of nets, etc. It will be found very convenient to have a chest fitted with trays dropping in from

above, to carry more readily and securely skins of birds, small mammals, eggs, etc.

2. Two copper kettles in one of the panniers or chests, to contain the alcohol for such specimens as require this mode of preservation, viz: Reptiles, fishes, sometimes birds, small quadrupeds, most insects, crabs, and all soft invertebrates.

3. Half a dozen or more tin preserving cans, of different sizes, from pint to gallon. These may replace the copper cans, though they are not so durable. Many of the ordinary stores of the expedition may be carried in these cans, which, when emptied, can then be used for preserving specimens.

4. An iron wrench to loosen the screw-caps of the copper kettles when too tight to be managed by hand.

5. Two India-rubber bags, one for each kettle. These are intended to be inflated inside of the kettles, and by displacing the alcohol cause it to rise to the edge of the brass cap, and thus fill the kettle. Unless this is done, and any unoccupied space thus filled up, the specimens will be washed against the sides of the vessel, and much injured.

6. Small bags made of lino, musquito-netting, or cotton, of different sizes, and open at one end. These are intended, in the first place, to separate the specimens of different localities from each other; and, in the second place, to secure them from mutual friction or other injury. These bags may be respectively 7 × 3 inches, 11 × 5, and 15 × 7: of the latter size one-third as many as of each of the others will be sufficient: about 100 may be taken in all. The number or name corresponding to the locality is to be marked on the outside with red chalk, or written with ink on a slip of parchment, and dropped inside. The specimens are then to be placed in the bag, a string tied round the open end, or the end pinned up, and the bag thrown into alcohol. A piece of parchment may also be pinned on the outside, so as at the same time to close the mouth of the bag by folding over once or twice. The ink of the parchment must be dry before the slip is moistened in any way.

N. B. All mammals, and fishes and reptiles over five or six inches in length should have a small incision made in the abdomen, to facilitate the introduction of the alcohol. Larger snakes and small quadrupeds, too large to preserve entire, may be skinned, and the skins placed in alcohol. The skin covering the belly in the mammals should always be loosened from its adhesion to the walls of the abdomen, to prevent the hair from coming out.

7. Pencils for marking the bags.

8. Parchment to serve as labels for the bags. This may also be cut up into strips, and fastened by strings to such specimens as are not suited for the bags. Leather, kid, buckskin, &c., will also answer as substitutes.

9. Fishing-line and hooks.

10. Small seines for catching fishes in small streams. The two ends should be fastened to brails or sticks (hoe-handles answer well), which are taken in the hands of two persons, and the net drawn both up and down stream. Fishes may often be caught by stirring up the gravel or small stones in a stream, and drawing the net rapidly down the current. Bushes or holes along the banks may be inclosed by the nets, and stirred so as to drive out the fishes, which usually lurk in such localities. These nets may be six or eight feet long.

11. Pocket scoop-net; and casting-net.

12. Alcohol. About five gallons to each travelling party. This should be about 95 per cent. in strength, and medicated by the addition of one ounce of tartar emetic to one gallon of alcohol, to prevent persons from drinking it.

13. Arsenic in pound tin canisters. This may be applied to the moist skins of birds and quadrupeds, either dry or mixed with alcohol. Arsenical soap may also be used.

14. Alum and saltpetre, finely powdered and intimately mixed in the proportion of two parts of the former, and one of the latter. Ten or fifteen pounds may be taken, to be used in the preparation of large skins. It can best be carried in the tin preserving cans, with screw caps, and applied from a small tin dredging box.

15. Tartar emetic for medicating the alcohol as above.

16. Some drachm bottles of strychnine for poisoning carnivorous animals—wolves, foxes, bears, etc.—and for protecting certain parts of skins from insects.

17. Some camphor.

18. Cotton or tow for stuffing out the heads of birds and mammals. To economize space, but little should be put into the bodies of the animals. The skulls of the quadrupeds, except very small ones, may be removed from the skins, but carefully preserved with a common mark.

19. Paper for wrapping up the skins of birds and small quadrupeds, each separately. The paper supplied for botanical purposes will answer for this.

20. A BALL OF STOUT COTTON TWINE.

21. A SHEET OF PARCHMENT.

22. BUTCHER KNIFE, SCISSORS, NEEDLES, AND THREAD, for skinning and sewing up animals: also, some papers of COMMON PINS.

23. BLANK LABELS of paper with strings attached for marking localities, sex, &c., and tying to the legs of the dried skins, or to the stems of plants. The name of the expedition and of its commander may be printed on the upper margin, and of the collector at the right end of the lower.

24. PORTFOLIO for collecting plants.

25. PRESS for drying plants between the blotting-paper. Pressure is applied by straps.

26. VERY ABSORBENT PAPER for drying plants.

27. STIFFER PAPER for collecting plants in the field. The same paper may be used for wrapping up skins of birds and quadrupeds, as well as minerals and fossils.

28. SMALL BOTTLES with wide mouths for collecting and preserving insects, etc. They should always be properly corked beforehand; 2 and 4 oz. are convenient sizes. Homœopathic bottles may also be added to advantage.

29. GEOLOGICAL HAMMER.

30. DOUBLE-BARRELLED GUN AND RIFLE; also shot-belt, powder-flask, powder, shot, percussion caps, and wadding.

31. FINE SHOT for small birds and mammals. Numbers 3, 6, and 9, or 10, are proper sizes; the latter should always be taken.

32. A POCKET CASE of dissecting instruments will be very convenient.

33. BLOWPIPE APPARATUS for mineralogical examinations.

34. POCKET VIAL for insects.

35. BOTTLE OF ETHER for killing insects.

36. INSECT PINS, and apparatus for capturing insects.

37. CORK-LINED BOXES.

38. POCKET NOTE-BOOK. The kind made of what is called metallic paper, with which a pewter pencil is used, is much the best, as not liable to being defaced. Every specimen should have its number, beginning with 1, marked on the label or object itself, and entered in the record, and but a single series for those dried and in alcohol. The different parts of the same object should have a single, common number, as a skin and its skull or skeleton; a bird and its nest or eggs, etc. Where several specimens of one locality are

enclosed in bags, however, a single number will suffice, unless some particular reference is to be made to any one of them. All notes of habits, etc., are to be made in the note-book; but the date, locality, and sex should be marked in addition on the label of the specimen.

§ II. INSTRUMENTS, PRESERVATIVE MATERIALS, &c.

1. IMPLEMENTS FOR SKINNING.

The implements generally required in skinning vertebrated animals are: 1. A sharp knife or a scalpel. 2. A pair of sharp-pointed scissors, and one with strong short blades. 3. Needles and thread for sewing up the incisions in the skin. 4. A pair of spring forceps, rather sharp pointed, for adjusting the skin and feathers of birds, especially about the head, and for other purposes. 5. A pair of long forceps for introducing cotton into the neck of animals, etc. 6. A hook by which to suspend the carcass of the animal during the operation of skinning. To prepare the hook, take a string, of from one to three feet in length, and fasten one end of it to a stout fish-hook which has had the barb broken off. By means of a loop at the other end, the string may be suspended to a nail or awl, which, when the hook is inserted into the body of an animal, will give free use of both hands in the operation of skinning.

2. PRESERVATIVES.

The best material for the preservation of skins of animals consists of powdered arsenious acid, or the common arsenic of the shops. This may be used in two ways, either applied in dry powder to the moist skin, or still better mixed with alcohol or water to the consistency of molasses, and put on with a brush. Some camphor may be added to the alcoholic solution, and a little strychnine will undoubtedly increase its efficacy. There are no satisfactory substitutes for arsenic; but, in its entire absence, corrosive sublimate, camphor, alum, &c., may be employed. Many persons prefer the arsenical soap to the pure arsenic. This is composed of the following ingredients: arsenic 1 oz.; white soap 1 oz.; carbonate of potash 1 drachm; water 6 drachms; camphor 2 drachms. Cut the soap into thin slices, and melt over a slow fire with the water, stirring it continually: when dissolved, remove from the fire

and add the potash and arsenic by degrees: dissolve the camphor in a little alcohol, and when the mixture is nearly cold stir it in.

The proper materials for stuffing out skins will depend much upon the size of the animal. For small birds and quadrupeds, cotton will be found most convenient; for the larger, tow. For those still larger, dry grass, straw, sawdust, bran, or other vegetable substances, may be used. Whatever substance be used, care must be taken to have it perfectly dry. Under no circumstances should animal matter, as hair, wool, or feathers, be employed.

The bills and loral region, as well as the legs and feet of birds. and the ears, lips, and toes of mammals, may, as most exposed to the ravages of insects, be washed with an alcoholic solution of strychnine applied with a brush to the dried skin; this will be an almost certain safeguard against injury.

§ III. SKINNING AND STUFFING.

1. BIRDS.

Whenever convenient, the following notes should be made previous to commencing the operation of skinning, as they will add much to the value of the specimens :—

1. The length, in inches, from tip of bill to the end of the tail; the distance between the two extremities of the outstretched wings; and the length of the wing from the carpal or first joint. The numbers may be recorded as follows: 44, 66, 12 (as for a swan), without any explanation; it being well understood that the above measurements follow each other in a fixed succession. These numbers may be written on the back of the label attached to each specimen.

2. The color of the eyes, that of the feet, bill, gums, membranes, caruncles, &c.

3. The date, the locality, and the name of the collector.

4. The sex. All these points should be recorded on the label.

Immediately after a bird is killed, the holes made by the shot, together with the mouth and internal or posterior nostrils, should be plugged up with cotton, to prevent the escape of blood and the juices of the stomach. A long narrow paper cone should be made; the bird, if small enough, thrust in, head foremost, and the open

end folded down, taking care not to bend or break or bend the tail feathers in the operation.*

When ready to proceed to skinning, remove the old cotton from the throat, mouth, and nostrils, and replace it by fresh. Then take the dimensions from the point of the bill to the end of the tail, from the tip of one wing to that of the other, when both are extended, and from the tip of the wing to the first or carpal-joint, as already indicated.

A recent author recommends† that the girth of the bird be taken before skinning, by means of a band of stiff paper passed round the middle of the body over the wings, and pinned in the form of a ring. It is then slipped off towards the feet, and after the skin is prepared, is replaced, the stuffing inserted being enough to keep it from falling off. The exact circumference of the original bird can thus be readily maintained. In fact, the ring may be slipped on before the stuffing is commenced, and enough cotton inserted to fill out the shoulders within the paper.

After these preliminaries, make an incision through the skin only, from the lower end of the breast bone to the anus. Should the intestines protrude in small specimens, they had better be extracted, great care being taken not to soil the feathers. Now proceed carefully to separate the skin on each side from the subjacent parts, until you reach the knee, and expose the thigh when, taking the leg in one hand, push or thrust the knee up on the abdomen, and loosen the skin around it until you can place the scissors or knife underneath, and separate the joint with the accompanying muscles. Place a little cotton between the skin and body to prevent adhesion. Loosen the skin about the base of the tail, and cut through the vertebræ at the last joint, taking care not to sever the basis of the quills. Suspend the body by inserting the hook into the lower part of the back or rump, and invert the skin, loosening it carefully from the body. On reaching the wings, which had better be relaxed previously by stretching and pulling, loosen the skin from around the first bone, and cut through the middle of it, or, if the bird be small enough, separate it from the next at the elbow. Continue the inversion of the skin by drawing

* Crumpled or bent feathers may have much of their elasticity and original shape restored by dipping in hot water.

† Davies' Naturalist's Guide. Edinburgh, 1858, page 19.

it over the neck, until the skull is exposed. Arrived at this point, detach the delicate membrane of the ear from its cavity in the skull, if possible, without cutting or tearing it; then, by means of the thumb-nails, loosen the adhesion of the skin to the other parts of the head, until you come to the very base of the mandibles, taking care to cut through the white nictitating membrane of the eye, when exposed, without lacerating the ball. Scoop out the eyes, and, by making one cut on each side of the head, through the small bone connecting the base of the lower jaw with the skull, another through the roof of the mouth at the base of the upper mandible, and between the jaws of the lower, and a fourth through the skull behind the orbits, and parallel to the roof of the mouth, you will have freed the skull from all the accompanying brain and muscle. Should anything still adhere, it may be removed separately. In making the first two cuts, care must be taken not to injure or sever the zygoma, a small bone extending from the base of the upper mandible to the base of the lower jaw-bone. Clean off every particle of muscle and fat from the head and neck, and, applying the preservative abundantly to the skull, inside and out, as well as to the skin, restore these parts to their natural position. In all the preceding operations, the skin should be handled as near the point of adhesion as possible, especial care being taken not to stretch it.

Finely powdered plaster of Paris, chalk, or whiting, may be used to great advantage by sprinkling on the exposed surface of the carcass, and inside of skin, to absorb the grease and blood.

An excellent suggestion of Mr. Davies, the author just quoted, in the case of greasy, fatty, or bloody specimens, is to have strips of calico or cotton cloth, and to baste them on the inside of the skin along the edges of the incision, so that they may project a little beyond the feathers. This will be exceedingly effectual in keeping the feathers clean. The cloth should be applied as soon as the edges of the first incision are raised enough to admit of it. This will answer the additional purpose of preventing the stretching of the skin.

The next operation is to connect the two wings inside of the skin by means of a string, which should be passed between the lower ends of the two bones forming the forearm, previously, however, cutting off the stump of the arm, if still adhering at the elbow. Tie the two ends of the strings so that the wings shall be kept at

the same distance apart as when attached to the body. Skin the leg down to the scaly part, or tarsus, and remove all the muscle. Apply the arsenic to the bone and skin, and, wrapping cotton round the bone, pull it back to its place. Remove all the muscle and fat which may adhere to the base of the tail or the skin, and put on plenty of the preservative wherever this can be done. Lift up the wing, and remove the muscle from the forearm by making an incision along it. In many cases, the two joints may be exposed by carefully slipping down the skin towards the wrist-joint, the adhesion of the quills to the bone being loosened: this is, however, scarcely an advisable method. It is perhaps generally better to clean the forearm from the inside before tying the wings.

The bird is now to be restored to something like its natural shape by means of a filling of cotton or tow. Begin by opening the mouth and putting cotton into the orbits and upper part of the throat, until these parts have their natural shape. Next take tow or cotton, and after making a roll rather less in thickness than the original neck, put it into the skin, and push firmly into the base of the skull. This can best be done by means of long forceps. By means of this, you can reduce or contract the neck if too much stretched. Fill the body with cotton, not quite to its original dimensions, and sew up the incision in the skin, commencing at the upper end, and passing the needle from the inside outwards; tie the legs and mandibles together, adjust the feathers, and, after preparing a cylinder of paper the size of the bird, or using one previously prepared as suggested on page 18, push the skin into it so as to bind the wings closely to the sides. The cotton may be put in loosely, or a body the size of the original made by wrapping with threads. If the bird have long legs and neck, these had better be folded down over the body, and allowed to dry in that position. Economy of space is a great object in keeping skins, and such birds as herons, geese, swans, &c., occupy too much room when outstretched.

In some instances, as among the ducks, woodpeckers, &c., the head is so large that the skin of the neck cannot be drawn over it. In such cases, skin the neck down to the base of the skull, and cut it off there. Then draw the head out again, and, making an incision on the outside, down the back of the skull, skin the head. Be careful not to make too long a cut, and to sew up the incision again.

The sex of the specimen may be ascertained after skinning, by making an incision in the side near the vertebræ, and exposing the inside surface of the "small of the back." The generative organs will be found tightly bound to this region (nearly opposite to the last ribs), and separating it from the intestines. The testicles of the male will be observed as two spheroidal or ellipsoidal whitish bodies, varying with the season and species, from the size of a pin's head to that of a hazel-nut. The ovaries of the female, consisting of a flattened mass of spheres, variable in size with the season, will be found in the same region.

Some writers advise a very careful cleaning out of the skull, without cutting away any of the bones, so that the skin, if otherwise useless, will at any time furnish a skull for the osteological series. This, however, requires so much more time, that it can scarcely be done on a journey, and a skull can generally be better obtained from another specimen, too much shot, perhaps, to be skinned.

The breast bone with its attachments, of at least one specimen of each species, should be cleaned and preserved.

For transportation, each skin of mammals as well as of birds should, when possible, be wrapped in paper, or else arranged in trays lined with cotton, and the interstices filled with the same material.

2. MAMMALS.

The mode of preparing mammals is precisely the same as for birds, in all its general features. Care should be taken not to make too large an incision along the abdomen. The principal difficulty will be experienced in skinning the tail. To effect this, pass the slipknot of a piece of strong twine over the severed end of the tail, and, fastening the vertebræ firmly to some support, pull the twine towards the tip until the skin is forced off. Should the animal be large, and an abundance of preservative not at hand, the skin may remain inverted. In all cases, it should be thoroughly and rapidly dried. Further remarks on this subject will be found in the introductory chapter.

The tails of some mammals cannot be skinned as directed above. This is particularly the case with beavers, opossums, and those species which use their tail for prehension or locomotion. Here the tail is usually supplied with numerous tendinous muscles, which

require it to be skinned by making a cut along the lower surface or right side, nearly from one end to the other, and removing the bone and flesh. It should then be sewed up again, after a previous stuffing.

For the continued preservation of hair or fur of animals against the attacks of moths and other destructive insects, it may be saturated with a solution of arsenic in water to be strained and applied rather warm. A little strychnine added will be of much service.

A free use of tobacco scraps among skins, though no security against the attacks of insects, will be of use. Kreosote is also an excellent remedy, though a disagreeable one. The Persian Insect powder (made from the leaves and stems of *Pyrethrum*, and forming the basis of the so-called magnetic powders of Lyon and others), when fresh, will also keep off insects. Perhaps none of these remedies, including ether, chloroform and turpentine, will kill larvæ; they may repel the perfect insect, but when the eggs are laid, there is scarcely any remedy except exposing the skins to a temperature a little below that of boiling water for ten or twelve hours, and thus drying up the egg or grub. The best plan therefore will be to keep the skins clean, and not packed too tightly, and in close fitting drawers or trays. (See also page 8.)

3. REPTILES.

The larger *lizards*, such as those exceeding twelve or eighteen inches in length, may be skinned according to the principles above mentioned, and then dried, although preservation in spirit, when possible, is preferable for all reptiles.

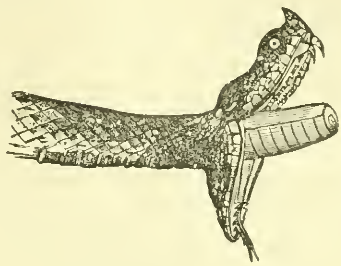
Large *frogs* and *salamanders* may likewise be skinned, although cases where this will be advisable are very rare.

Turtles and *large snakes* will require this operation.

To one accustomed to the skinning of birds, the skinning of frogs or other reptiles will present no difficulties.

The skinning of a snake is still easier. Open the mouth and separate the skull from the vertebral column, detaching all surrounding muscles adherent to the skin. Next, tie a string around the stump of the neck thus exposed (see figure), and, holding on by this, strip the skin down to the extremity of the tail. The skin thus inverted should be restored to its proper state, and then put in spirit or stuffed, as convenient. Skins of reptiles may be stuffed

with either sand or sawdust, by the use of which their shape is more easily restored, or they may be simply flattened out.



Turtles and tortoises are more difficult to prepare in this way, although their skinning can be done quite rapidly. "The breastplate must be separated by a knife or saw from the back, and, when the viscera and fleshy parts have been removed, restored to its position. The skin of the head and neck must be turned inside out, as far as the head, and the vertebræ and flesh of the neck should be detached from the head, which, after being freed from the flesh, the brain, and the tongue, may be preserved with the skin of the neck. In skinning the legs and the tail, the skin must be turned inside out, and, the flesh having been removed from the bones, they are to be returned to their places by redrawing the skin over them, first winding a little cotton or tow around the bones to prevent the skin adhering to them when it dries."—Richard Owen.

Another way of preparing these reptiles is as follows: Make two incisions, one from the anterior end of the breastplate to the symphysis of the lower jaw, and another from the posterior end of the breastplate to the vent or tip of the tail; skin off these regions and remove all fleshy parts and viscera without touching the breastplate itself. Apply the preservative, stuff, and sew up again both incisions.

"When turtles, tortoises, crocodiles, or alligators, are too large to be preserved whole in liquor, some parts, as the head, the whole viscera stripped down from the neck to the vent, and the cloaca, should be put into spirit or solution."—R. Owen.

4. FISHES.

As a general rule, fishes, when not too large, are best preserved entire in spirits.

Nevertheless, they may be usefully skinned and form collections, the value of which is not generally appreciated. In many cases, too, when spirit or solutions cannot be procured, a fish may be preserved which would otherwise be lost.

There are two modes of taking the skin of a fish: 1. The whole animal can be skinned and stuffed like a bird, mammal, or reptile. 2. One-half of the fish can be skinned, and nevertheless its natural form preserved.

Sharks, skates, sturgeons, garpikes or *garfishes, mudfishes*, and all those belonging to the natural orders of *Placoids* and *Ganoids*, should undergo the same process as given above for birds, mammals, and reptiles. An incision should be made along the right side, the left always remaining intact, or along the belly. The skin is next removed from the flesh, the fins cut at their bases under the skin, and the latter inverted until the base of the skull is exposed. The inner cavity of the head should be cleaned, an application of preservative made, and the whole, after being stuffed in the ordinary way, sewed up again. Fins may be expanded when wet, on a piece of stiff paper, which will keep them sufficiently stretched for the purpose. A varnish may be passed over the whole body and fins, to preserve somewhat the color.

In the case of *Ctenoids*, perches, and allied genera; and *Cycloids* trouts, suckers, and allied genera; one-half of the fish may be skinned and preserved. To effect this, lay the fish on a table with the left side up; the one it is intended to preserve. Spread out the fins by putting underneath each a piece of paper, to which it will adhere on drying. When the fins are dried, turn the fish over, cut with scissors or a knife all around the body, a little within the dorsal and ventral lines, from the upper and posterior part of the head, along the back to the tail, across the base of the caudal fin down, and thence along the belly to the lower part of the head again. The dorsal, caudal, and anal fins, cut below their articulations. This done, separate the whole of the body from the left side of the skin, commencing at the tail. When near the head, cut off the body, with the right ventral and pectoral fins, and proceed by making a section of the head and removing nearly the half of it. Clean the inside, and pull out the left eye, leaving only the cornea and pupil. Cut a circular piece of black paper of the size of the orbit and place it close to the pupil. Apply the preservative, fill the head with cotton as well as the body. Turn over the

skin and fix it on a board prepared for that purpose. Pin or tack it down at the base of the fins. Have several narrow bands of paper to place across the body in order to give it a natural form, and let it dry. The skins may be taken off the board or remain fixed to it, when sent to their destination, where they should be placed on suitable boards of proper size, for permanent preservation.

Such a collection of well-prepared fishes will be useful to the practical naturalist, and illustrate, in a more complete manner, to the public the diversified forms and characters of the class of fishes which specimens preserved in alcohol do not so readily show.

These skins may also be preserved in alcohol.

§ IV. PRESERVING IN LIQUIDS, AND BY OTHER MODES BESIDES SKINNING.

1. GENERAL REMARKS.

The best material for preserving animals of moderate size is alcohol. When spirits cannot be obtained, the following substitutes may be used :—

I. Goadby's Solution.—A. *The aluminous fluid,* composed of rock salt, 4 ounces; alum, 2 ounces; corrosive sublimate, 4 grains; boiling water, 2 quarts. B. *The saline solution,* composed of rock-salt, 8 ounces; corrosive sublimate, 2 grains; boiling water, 1 quart. To be well stirred, strained, and cooled.

II. A strong brine, to be used as hereafter indicated for Goadby's Solution.

III. In extreme cases, dry salt may be used, and the specimens salted down like herring, &c.

The alcohol, when of the ordinary strength, may be diluted with one-fifth of water, unless it is necessary to crowd the specimens very much. The fourth proof whiskey of the distillery, or the high wines, constituting an alcohol of about 60 per cent., will be found best suited for collections made at permanent stations and for the museum. Lower proofs of rum or whiskey will also answer, but the specimen must not be crowded at all.

To use Goadby's Solution, the animal should first be macerated for a few hours in fresh water, to which about half its volume of

the concentrated solution may then be added. After soaking thus for some days, the specimens may be transferred to fresh concentrated solution. When the aluminous fluid is used to preserve vertebrate animals, these should not remain in it for more than a few days; after this, they are to be soaked in fresh water, and transferred to the saline solution. An immersion of some weeks in the aluminous fluid will cause a destruction of the bones. Specimens must be kept submerged in these fluids. The success of the operation will depend very much upon the use of a weak solution in the first instance, and a change to the saturated fluid by one or two intermediate steps.

The collector should have a small keg, jar, tin box, or other suitable vessel, partially filled with liquor, into which specimens may be thrown (alive if possible) as collected. The entrance of the spirit into the cavities of the body should be facilitated by opening the mouth, making a small incision in the abdomen a half or one inch long, or by injecting the liquor into the intestines through the anus, by means of a small syringe. After the animal has soaked for some weeks in this liquor, it should be transferred to fresh. Care should be taken not to crowd the specimens too much. When it is impossible to transfer specimens to fresh spirits from time to time, the strongest alcohol should be originally used.

To pack the larger specimens for transportation, procure a small keg, which has been properly swelled, by allowing water to stand in it for a day or two, and from this extract the head by knocking off the upper hoops. Great care must be taken to make such marks on the hoops and head as will assist in their being replaced in precisely the same relative position to each other and the keg that they originally held. At the bottom of the keg place a layer of tow or rags, moistened in liquor, then one of specimens, then another of tow and another of specimens, and so on alternately until the keg is *entirely filled*, exclusive of the spirit. Replace the head, drive down the hoops, and fill completely with spirits by pouring through the bung-hole. Allow it to stand at least half an hour, and then, supplying the deficiency of the liquor, insert the bung and fasten it securely. An oyster-can or other tin vessel may be used to great advantage, in which case the aperture should be soldered up and the vessel inclosed in a box. A glass jar or bottle may also be employed, but there is always a risk of breaking and leaking. The specimens may also be transported in the copper

vessels referred to on pages 9 and 13, and also in the tin preserving cans. In the absence of tow or rags, chopped straw, fine shavings, or dry grass may be substituted.

It will conduce greatly to the perfect preservation of the specimens, during transportation, if each one is wrapped up in cotton cloth, or even paper. A number of smaller specimens may be rolled successively in the same wrapper. In this way, friction, and the consequent destruction of scales, fins, &c., will be prevented almost entirely. The travelling bags described on p. 13 will answer the same purpose.

Should the specimens to be packed vary in size, the largest should be placed at the bottom. If the disproportion be very great, the delicate objects at the top must be separated from those below by means of some immovable partition, which, in the event of the vessel being inverted, will prevent crushing. The most imperative rule, however, in packing, is to have the vessel perfectly full, any vacancy exposing the whole to the risk of loss.

It is sometimes necessary to guard against the theft of the spirit employed by individuals who will not be deterred from drinking it by the presence of reptiles, &c. This may be done by adding a small quantity of tartar emetic, ipecacuanha, quassia, or some other disagreeable substance. The addition of a little arsenic will add to the preservative power of the spirit. A small quantity of soap is said to have a remarkable effect in preserving the color; a little saltpetre appears to have also the same effect.

2. VERTEBRATES.

Mammals and birds should always have an incision made in the abdomen to admit the spirit. In the former the skin on each side of the cut should also be raised or separated from its attachment to the subjacent walls, to prevent the hair from coming off. Where several specimens of a kind are preserved it will be well to remove the intestines entirely from some of them, to insure their sound preservation.

Fishes over five or six inches in length should also have the abdominal incision. Specimens with the scales and fins perfect should be selected, and, if convenient, stitched, pinned, or wrapped in bits of muslin, &c., to preserve the scales; placing them in the lino bags will answer the latter object. In general, fishes under

twelve or fifteen inches in length should be chosen. The skins of larger ones may be put in liquor. It is important to collect even the smallest. The same principles apply to the other vertebrata.

The smallest and most delicate specimens may be placed in bottles or vials, and packed in the larger vessels with the other specimens.

3. INVERTEBRATES.*

INSECTS, BUGS, &c.—The harder kinds may be put in liquor, as above, but the vessel or bottle should not be very large. Butterflies, wasps, flies, &c., should be pinned in boxes, or packed in layers with soft paper or cotton. Minute species should be carefully sought under stones, bark, dung, or flowers, or swept with a small net from grass or leaves. They may be put in quills, small cones of paper, or in glass vials. They can be readily killed by immersing the bottles, &c., in which they are collected, in hot water, or exposing them to the vapor of ether. Large beetles, however, can generally only be killed by piercing with some poisonous solution, as strychnine.

When possible, a number of oz. or 2 oz. vials, with very wide mouths, well stopped by corks, should be procured, in which to place the more delicate invertebrata, as small crustacea, worms, mollusca, &c.

It will frequently be found convenient to preserve or transport insects pinned down in boxes. The bottoms of these are best lined with cork or soft wood. The accompanying figures will explain, better than any description, the particular part of different kinds of insects through which the pin is to be thrust; beetles (Fig. 1) being pinned through the right wing-cover or elytra; all others through the middle of the thorax, as in Fig. 2.

The traveller will find it very convenient to carry about him a vial having a broad mouth, closed by a tight cork. In this should be contained a piece of camphor, or, still better, of sponge soaked in ether, to kill the insects collected. From this the specimens should be transferred to other bottles. They may, if not hairy, be killed by immersing directly in alcohol.

* A separate pamphlet in reference to collecting insects will be published by the Institution, and a special chapter on marine invertebrates will be found at the end of the present work.

A lump of camphor may be placed in a piece of cotton cloth and pinned firmly in the corner of the box containing dried insects, for the purpose of preventing the ravages of larvæ. A few drops of kreosote occasionally introduced will also answer the same purpose.

Fig. 1.

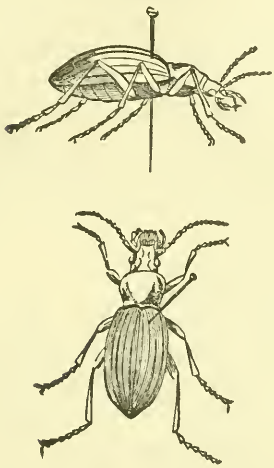
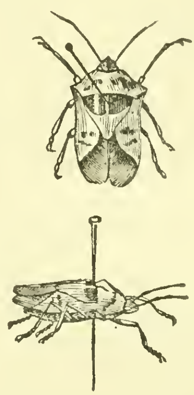


Fig. 2.



Sea-urchins and starfishes may be dried, after having been previously immersed for a minute or two in boiling water, and packed up in cotton, or any soft material which may be at hand.

The hard parts of coral, and shells of mollusca may also be preserved in a dried state. The soft parts are removed by immersing the animals for a minute or two in hot water, and washing clean afterwards. The valves of bivalve shells should be brought together by a string.

Wingless insects, such as spiders, scorpions, centipedes or thousand-legs, earth-worms, hair-worms, and generally all worm-like animals found in the water, should be preserved in alcoholic liquor, and in small bottles or vials.

§ V. EMBRYOS.

Much of the future progress of zoology will depend upon the extent and variety of the collections which may be made of the embryos and fœtuses of animals. No opportunity should be

omitted to procure these and preserve them in spirits. All stages of development are equally interesting, and complete series for the same species would be of the highest importance. Whenever any female mammal is killed, the uterus should be examined for embryos. When eggs of birds, reptiles, or fish are emptied of their young, these should be preserved. It will be sufficiently evident that great care is required to label the specimens, as in most cases it will be impossible to determine the species from the zoological characters.

Whenever the abundance of specimens will warrant it, as many as fifty eggs of the same kind of bird, in different degrees of development, may be collected, care being taken to crack the egg at the blunt end, to facilitate the entrance of the spirit.

§ VI. NESTS AND EGGS.*

Nothing forms a more attractive feature in a museum, or is more acceptable to amateurs, than the nests and eggs of birds. These should be collected whenever they are met with, and in any number procurable for each species, as they are always in demand for purposes of exchange. Hundreds of eggs of *any* species with their nests (or without, when not to be had) will be gladly received.

Nests require little preparation beyond packing so as to be secure from crumbling or injury. Each one should be placed in a box or ring of paper just large enough to hold it. The eggs of each nest, when emptied, may be replaced in it and the remaining space filled with cotton.

Eggs, when fresh, and before the chick has formed, may be emptied by making small pin-holes on opposite sides, and blowing or sucking out the contents. Should hatching have already commenced, an aperture may be made in one side by carefully pricking with a fine needle round a small circle or ellipse, and thus cutting out a piece. The larger kinds should be well washed inside, and all allowed to dry before packing away. If the egg be too small for the name, a number should be marked on it with ink corresponding to a memorandum list. Little precaution is required in packing, beyond arranging in layers with cotton and having the box entirely

* A separate pamphlet has been published by the Institution in regard to the collecting of nests and eggs.

filled. It is always better to wrap each egg in a loose coat of cotton before arranging in layers, and they should be packed in small wooden boxes.

Cracked eggs should have strips of tissue paper pasted over the line of fracture; or the crack may be painted over with collodion while the sides are pressed together.

The parent bird should be secured, and either skinned entire or the head and wing kept to identify the species.

The eggs of reptiles, provided with a calcareous shell, can be prepared in a similar way.

The eggs of fishes, salamanders, and frogs may be preserved in spirits, and kept in small vials or bottles. A label should never be omitted.

§ VII. PREPARATION OF SKELETONS.

Skulls of animals may be rapidly prepared by boiling in water for a few hours. A little potash or lye added will facilitate the removal of the flesh.

Skeletons may be roughly prepared in the field by skinning the animal and removing all the viscera, together with as much of the flesh as possible. Whenever practicable, they should be allowed to soak a few hours in water to extract the blood. The bones should then be exposed to the sun or air until completely dried. Previously, however, the brain of large animals should be removed by separating the skull from the spine, and extracting the brain through the large hole in the back of the head. The head may be cleaned by boiling. In case it becomes necessary to disjoint a skeleton, care should be taken to attach a common mark to all the pieces, especially when more than one individual is packed in the same box.

Skulls and skeletons may frequently be picked up, already cleaned by other animals or exposure to weather. By placing small animals near an ant's nest, or in water occupied by tadpoles or small crustacea, very beautiful skeletons may often be obtained. The sea-beach sometimes affords rich treasures in the remains of porpoises, whales, large fishes, as sharks, and other aquatic species.

Although, to save time and opportunities in the field, it is usually necessary to prepare skulls by boiling in water, as just explained, the process is sometimes apt to leave the bones colored, or even somewhat greasy. The best method of preparing skulls

and skeletons for a museum is undoubtedly, after cutting away the greater mass of flesh, that of macerating, or allowing them to remain in cold water until the decaying flesh separates from the bones. At first, the water, as it becomes charged with blood, is poured off and replaced by fresh; after this is repeated for a time, the flesh becomes bleached, and the bones may then be suffered to remain as long as necessary (sometimes for weeks), removing the specimen from time to time and scraping off the softening flesh. After this has been all removed and the bones well scrubbed under water with a stiff brush, they should be soaked a little longer to remove any remnant of infiltrated blood. During these operations, care must be taken not to injure or separate any of the ligaments. Shreds of tendon may be cut off with a sharp knife or pair of scissors. The ligaments may then, according to Eyton,* be converted into a tough, leathery substance by immersion in a liquid prepared by making a saturated solution of common alum and, when cold, diluting it with an equal quantity of water, and adding half an ounce of common salt for every half pound of alum. If the bones are free from blood, twenty-four hours' immersion will be sufficient; large birds or other animals may require nearly a week. When removed from the solution, the bones must be washed under a current of water, or in a basin, and then allowed to dry in any desirable position.

It is important, in preparing skeletons, not to allow the flesh to dry too soon on the bones, or, at least, to allow them to soak in water for a time before drying, as the subsequent operations will be rendered much easier.

Greasy skulls or bones can be readily cleaned by immersion in ether for a length of time. The ether should be kept in a tight jar, and every precaution taken to prevent undue proximity to a light or the fire, the vapor being exceedingly explosive. A simpler method consists in boiling them in a large quantity of water, having a little potash added.

§ VIII. PLANTS.

The collector of plants requires but little apparatus; a few quires or reams of unsized paper, of folio size, will furnish all that will be

* Ibis, I, 1859, 55.

needed. The specimens as gathered may be placed in a tin box, or, still better, in a portfolio of paper, until reaching home. About forty or fifty sheets of the paper should be put into the portfolio on setting out on an excursion. Put the specimens of each species in a separate sheet as fast as gathered from the plant, taking a fresh sheet for each additional species. On returning to camp, place these sheets (without changing or disturbing the plants) between the absorbent drying papers in the press, and draw the straps tight enough to produce the requisite pressure. The next day the driers may be changed, and those previously used laid in the sun to dry; this to be continued until the plants are perfectly dry. If paper and opportunities of transportation be limited, several specimens from the same locality may be combined in the same sheet after they are dry.

Place in each sheet a slip of paper having a number or name of locality written on it corresponding with a list kept in a memorandum book. Record the day of the month, locality, size, and character of the plant, color of flower, fruit, &c.

If the stem is too long, double it or cut it into lengths. Collect, if possible, half a dozen specimens of each kind. In the small specimens, collect the entire plant, so as to show the root.

In many instances, old newspapers will be found to answer a good purpose both in drying and in keeping plants, although the unprinted paper is best—the more porous and absorbent the better.

When not travelling, pressure may be most conveniently applied to plants by placing them between two boards, with a weight of about 50 lbs. laid on the top.

While on a march, the following directions for collecting plants, drawn up by Major Rich, are recommended :—

Have thick cartridge or envelop paper, folded in *quarto* form, and kept close and even by binding with strong cord ; newspapers will answer, but are liable to chafe and wear out ; a few are very convenient to mix in with the hard paper as dryers. This herbarium may be rolled up in the blanket while travelling, and placed on a pack-animal. The specimens collected along the road may be kept in the crown of the hat when without a collecting-box, and placed in paper at noon or at night. Great care should be taken to keep the papers dry and free from mould. When there is not time at noon to dry the papers in the sun, they should be dried at night by the fire, when, also, the dried specimens are

placed at the bottom of the bundle, making room on top for the next day's collection. A tin collecting-box is very convenient; plants may be preserved for two or three days in one if kept damp and cool. It is also convenient in collecting *land-shells*, which is generally considered part of a botanist's duty. A collector should also always be provided with plenty of ready-made seed-papers, not only for preserving seeds, but mosses and minute plants. Many seeds and fruits cannot be put in the herbarium, particularly if of a succulent nature, causing mouldiness, and others form irregularities and inequalities in the papers, thus breaking specimens and causing small ones and seeds to drop out. Fruits of this kind should be numbered to correspond with the specimen, and kept in the saddle-bags, or some such place. It is necessary, in order to make good specimens, to avoid heavy pressure and keep the papers well dried, otherwise they get mouldy, turn black, or decay.

The seeds and fruits of plants should be procured whenever practicable, and slowly dried. These will often serve to reproduce a species otherwise not transportable or capable of preservation.

On board ship, it is all-important to keep the collections from getting wet with salt water. The papers can generally be dried at the galley. The whole herbarium should be exposed to the sun as often as possible, and frequently examined, and the mould brushed off with a feather or camel-hair pencil.

In collecting algæ, corallines, or the branched, horny, or calcareous corals, care should be taken to bring away the entire specimen with its base or root. The coarser kinds may be dried in the air (but not exposed to too powerful a sun), turning them from time to time. These should not be washed in fresh water, if to be sent any distance. The more delicate species should be brought home in salt water, and washed carefully in fresh, then transferred to a shallow basin of clean fresh water, and floated out. A piece of white paper of proper size is then slipped underneath, and raised gently out of the water with the specimen on its upper surface. After finally adjusting the branches with a sharp point or brush, the different sheets of specimens are to be arranged between blotters of bibulous paper and cotton cloth, and subjected to gentle pressure. These blotters must be frequently changed till the specimens are dry.

§ IX. MINERALS AND FOSSILS.

The collections in mineralogy and palæontology are, amongst all, those which are most easily made; whilst, on the other hand, their weight, especially when travelling, will prevent their being gathered on an extensive scale.

All the preparation usually needed for preserving minerals and fossils consists in wrapping the specimens separately in paper, with a label inside for the locality, and packing so as to prevent rubbing. Crumbling fossils may be soaked to advantage in a solution of glue. Melted wax also answers an admirable purpose in the case of bones.

Fossils of all kinds should be collected. Minerals and samples of rocks are also desirable. The latter should be properly selected, and cut to five by three inches of surface and one to two inches thick.

The vertebrate fossils of North America are of the highest interest to naturalists. These are found in great abundance in the regions known as "Mauvaises Terres," or "Bad Lands," and occurring along the Missouri and its tributaries, White River, Milk River, Platte, Eau qui Court, &c. The banks and beds of these and other streams likewise contain rich treasures of fossil bones. Similar remains are to be looked for in all caves, peat bogs, alluvial soil, marl-pits, fissures in rocks, and other localities throughout North America. Single teeth, when found, should be carefully preserved.

The floor of any cavern, if dug up and carefully examined, will generally be found to contain teeth, bones, &c. These, however similar in appearance to recent or domesticated species, should be carefully preserved.

Specimens ought to be tightly packed up in boxes, taking care that each one is wrapped up separately, in order that the angles or any crystalline surfaces should not be destroyed by transportation; their value depending upon their good condition. The same precautions will be required for corals. The interstices between the specimens, in the box or cask, may be occupied by sand, shavings, hay, cotton, or other soft substance. Sawdust is considered objectionable on account of its settling too much. It is absolutely essential that no cavity be left in the vessel or box.

§ X. MINUTE MICROSCOPIC ORGANISMS.

It is very desirable to procure specimens, from many localities, of the various forms of microscopic animals and plants, not only on account of their intrinsic interest, but for their relation to important general questions in physical and natural science. These will almost always be found to occur in the following localities:—

1. In all light-colored clays or earths, as found in peat bogs, meadows, soils, &c., particularly when these are remarkably light.

2. In the mud from the bottom of lakes and pools. A small handful of this mud or of the confervoid vegetation on the bottom, if dried *without squeezing*, will retain the Diatomaceæ and Desmidieæ.

3. In the mud (dried) from the bottom and along the margins of streams in any locality. The muds from brackish and from fresh waters will differ in their contents.

4. In soil from the banks of streams. The surface and subsoils should both be collected.

5. In the soundings brought up from the bottom of the sea or lakes. These should be collected from the greatest possible depths. If an armature be used to the lead, it should be of soap rather than fatty matter, as being more readily removed from the organisms. The mud which adheres to anchors, to rocks, &c., below *high*-water-mark, as well as below *low*-water, should also be carefully gathered.

6. In bunches of damp moss from rocks, roofs of houses, trees, about pumps, &c.

7. In the deposits in the gutters and spouting of roofs of houses.

8. In the dust which at sea collects upon the sails or deck of vessels. When not in sufficient quantity to be scraped off, enough may be obtained for examination by rubbing a piece of soft clean paper over the surface affected.

Specimens of all these substances should be gathered, and, when moist, dried *without squeezing*. The quantity may vary from a few grains to an ounce, depending on the mode of transportation to be adopted. *Every specimen, as collected, should have the date, locality, depth below the surface, collector, &c., marked immediately upon the envelop.*

It is also desirable to collect filterings from river, brackish, and

sea-waters. To do this, take a circular piece of filtering-paper, six inches or thereabouts in diameter (blotting-paper will answer if the other cannot be procured). Pass a quantity of the water, varying with its turbidity from a pint to a gill, through the paper, and allow this to dry. Mark the paper or its envelop with the amount of water passed through, date, place, &c. It is desirable to have specimens thus prepared for every locality and for every month in the year. They may be sent, as well as light packages of dried muds, &c., by mail, and should be transmitted as speedily as possible. Unless the operation can be performed by an experienced hand, the weighing may be dispensed with.

When the water of lakes and ponds has been rendered turbid by minute green or brown specks, these should be gathered by filtration through paper or rag, which may then be dried, or, still better, this matter may be scraped off into a small vial of alcohol.

§ XI. ON THE COLLECTION AND PRESERVATION OF MARINE INVERTEBRATES.*

CLASSIFICATION.—The animals inhabiting the sea, excluding the fishes and other vertebrates, may be divided, for convenience, into groups, as follows: 1st. CRUSTACEANS, including crabs, hermits or soldier crabs, lobsters, *langoustes*, cray-fish, *camerones*, shrimps, prawns, sand-hoppers, beach-fleas, whale-lice, sea-creepers, pill-balls, fish-lice, sea-spiders, water-fleas, gill-suckers, and other parasites on fish, also barnacles. 2d. ANNELIDS, including all kinds of sea-worms, some of which hide among seaweed and pebbles, but most of which live in mud or sand, many having tubes. 3d. CEPHALOPODS, or cuttle-fishes and squids. 4th. NAKED MOLLUSCS, or sea-slugs. 5th. SHELLS, both bivalve and univalve. 6th. TUNICATES, vulgarly called "sea-squirts," consisting simply of leathery balls or sacks of various shapes, with two apertures, often occurring in compound forms. 7th. BRYOZOANS, or those minute coral-like incrustations found on seaweeds, stones, and old shells. 8th. HOLOTHURIANS, those worm-like or slug-like echinoderms like the biche-le-mer or trepang. 9th. ECHINI, sea-eggs or sea-urchins, most of which resemble chestnut burrs, being covered with spines. 10th. ASTERIAS and star-fishes of all kinds. 11th. POLYPS, including

* Prepared by Mr. Wm. Stimpson.

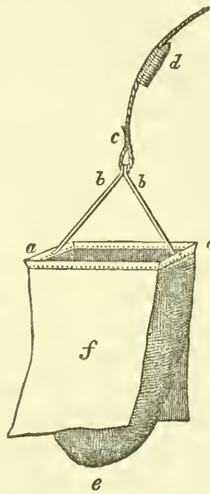
corals and corallines, and those minute animals from which the medusæ are developed. And 12th. SPONGES.

LOCALITIES AND STATIONS.—Where the retreat of the tide is sufficient, the sea-shore always affords the best field for the collector, and the specimens generally increase in number and interest in proportion as we approximate to low-water-mark. Nevertheless the whole area should be searched, as each species has its peculiar range, and many forms can live only where they are exposed to the air for a greater part of the time each day. The ground may be either muddy, sandy, weedy, gravelly, stony or rocky, and the animals inhabiting each kind of ground will be found to be more or less peculiar to it, and rarely to occur on the others. *Sand* and *mud* are, however, so similar in character that their denizens are nearly the same, though some prefer the clearer waters which flow over sand, to the turbid tide which deposits mud. But few specimens will be found on the surface of such ground, although the little pools lying upon it should be scooped with the dip net for shrimps, etc., but it is only by the spade that its true riches can be developed. By digging in spots indicated by small holes, a great number of worms, boring crustaceans, and bivalves may always be found. *Weedy ground* is so called from the abundance of eel-grass and sea-weed which covers it. These weeds should be examined carefully for small shells and crustaceans; perhaps the best method of doing this being to wash quantities of the weed in a bucket of water and examine the sediment. *Gravelly ground* is not generally very rich in animal life, but will repay an examination, as small crabs are fond of lurking among the pebbles. *Stony ground* is by far the richest of all. Wherever there are stones, particularly flat ones, about large enough to afford a moderate degree of exercise to a common sized man in turning them over, there the zoologist can never fail to fill his basket and bottles; for beneath these stones myriads of rare and beautiful species retire for moisture and protection during the retreat of the tide. *Rocky ground* should be searched chiefly in the pools and crevices.

Littoral or sea-shore investigations should be carried on not only in the bays, harbors, and creeks, but on the ocean beach, in each locality, to get at a true idea of its fauna, as the respective animals will be found different.

DREDGING.—A large proportion of the marine invertebrates never approach the shore closely enough to be left exposed by the tide,

and these can only be obtained with certainty and facility by means of the *dredge.* This consists of a rectangular frame of iron, the longer sides of which are sharpened in front and beveled outward a little. Along the back of the frame holes are perforated for the attachment of a fine meshed net, and to the short sides handles are hinged, which may be folded down in packing. There should be a ring at the end of each handle, and through these rings the rope may be passed when the handles are raised, which will be found a simple and sufficiently safe method of fastening the dredge for use. A weight should be attached to the rope two or three feet in front of the dredge, which is useful in sinking and keeping it in proper position when operating in deep water. On each of the longer sides of the frame there should be a leather flap, attached, for the protection of the net. The following are convenient dimensions for the apparatus: Frame, *a*, *a*, 20 inches long by 10 inches broad, of bar-iron, $1\frac{1}{2}$ inches wide and one-fifth of an inch thick. Handles, *b*, *b*, each 17 inches long, of half-inch rod-iron. Bag, *e*, three feet long, of mesh as fine as can be got, and strong twine; size of aperture rather larger than that of the frame. Rope, *c*, 20 to 200 fathoms to suit the depth of water. Weight, *d*, 5lbs.; an iron window-weight answers the purpose, and is much cheaper than lead.



The dredge should be carefully cast mouth-downward, that the tail of the net may not foul the handles or scythes. No precise directions can be given as to the amount of scope of warp to be let out;—about twice the depth of water is generally sufficient, but this should be diminished or increased in proportion as the dredge nips too hard or slides too easily over the ground, which may be readily determined by feeling the rope. The dredge is liable to be caught on rocky bottoms. When the check is felt, it is usually only necessary to heave in a portion of the warp, but sometimes the boat must be put about and run in an opposite direction.

All bottoms should be searched with the dredge, but gravelly and shelly ground will be found most productive. The boat may

be propelled by sails if sufficient care be taken to graduate the amount of canvas to the strength of the wind, in order that the dredge may move slowly over the bottom. Oars are safer, if the force is at command; and in a tide-way, the tide alone may move the boat with sufficient power, the rope being made fast amidships, or towards the bows, according to the strength of the current. Dredging may be carried on at all depths inside of 200 fathoms.

Instruments for Collecting.—For shore collecting, a broad flat basket, with jars or tin-cans, of various sizes, for the smaller and more delicate animals, which should be brought home in sea-water. A spade, trowel, and a strong knife for detaching limpets and tunicates from the rocks. A small dip-net is quite indispensable. In dredging, besides the baskets and bottles, one or more buckets are necessary, as many of the larger animals, such as star-fishes, are fragile, and can only be brought safely home in sea-water. And, above all, there should be wire-sieves for washing out the sand or mud brought up from soft bottoms.

Preservation of Specimens.—Alcoholic fluid is the only medium in which marine invertebrates can be properly preserved, shells and corals alone being excepted. Dried specimens are always in danger from dampness and breakage, and when sent to the Museum, seldom reach their destination uninjured. In placing the specimens in kegs, cans, jars, or bottles, a few rules should be carefully observed: 1st. Never crowd them too much; a bottle should be not more than half filled with specimens, but must be always entirely filled with alcohol. 2d. Adapt the bottles to the size of the specimens, placing small ones in small bottles, or, if very minute, in homœopathic vials. 3d. Never put soft and delicate forms with hard or spinous ones, which would injure them in any agitation. Each jar or bottle should contain specimens from one locality and station, which should be indicated in full on the label—the nature of the ground, distance from low water mark, and, if dredged, the depth of water being noted. In the larger kegs or cans, if specimens from more than one locality are included, each should have a parchment label attached, with the notes written in ink.

CIRCULAR

TO

OFFICERS OF THE HUDSON'S BAY COMPANY.

The Smithsonian Institution has been engaged for several years in the prosecution of researches relative to the climatology and natural history of the continent of North America. For this purpose the voluntary services of a large body of intelligent correspondents, distributed throughout the entire territory of the United States, have been secured, from whom records of changes of the weather, and other phenomena, with facts and specimens in natural history of much interest, have been obtained.

The observations thus accumulated have been reduced, and the results will shortly be published, both in tabular form and on maps, illustrating the lines of equal temperature: of rain at different points: the mean direction and intensity of the wind: the character of the land, whether forest or prairie, fertile or barren: the distribution of various animals and vegetables, etc. Reports have been issued, or are in preparation, embodying detailed monographic descriptions of the Algæ, the forest trees, the Vertebrata, insects, Mollusca, Crustacea, &c., of the continent; and efforts made generally to furnish a full and perfect account of its natural and physical history.

In the prosecution of these researches, a serious obstacle has been experienced in the lack of sufficient data from the region north of the boundary line of the United States, especially from its more northern portion. The isolated observations and collections, which have from time to time been received, have proved of great interest and importance; but the Institution now desires

to receive communications, if possible, from all inhabited portions of North America, especially from the stations of the Hon. Hudson's Bay Company. And with this view it has obtained the sanction of the proper authorities for an application to the officers of the Company for assistance, as shown by the accompanying letter of Sir George Simpson, Governor of the H. B. Territory.

The attention of the friends of science is therefore respectfully invited to certain points, which will be referred to more fully hereafter. In an accompanying package will be found detailed instructions in regard to making and recording observations, and it is only necessary here to indicate a few subjects which are of more particular interest.

1st. The beginning and ending of storms of wind and rain, and the time when the sky is overcast. Records of this kind enable us to map the face of the heavens over a large surface of country, and to determine the extent of a cloud, or of falling rain, snow, &c.

Beside the regular variations of the meteorological instruments, special information is desired as to the occurrence of thunder storms; the time of day at which they take place; the direction from which they come; their duration and intensity; notice of trees or other objects which may be struck by lightning.

2d. Tornadoes, land and water-spouts, and whirlwinds. The width of the path along which the mechanical effects are produced; the direction of the path; the appearance of the tornado at a distance; the motion of the clouds over the head of the observer as the tornado approaches and as it recedes from him. Note whether any electrical phenomena are exhibited, such as thunder, lightning, and luminous appearances; the mechanical effects, prostration of trees, and translation of heavy bodies.

3d. The aurora borealis: time of its beginning and ending; time of the formation of arch, beams, and corona; and whether there is a dark cloud below the arch; and other points mentioned in the pamphlet of instructions.

4th. Time of early and late frosts, particularly first and last. Depth of ground frozen, in feet and inches; disappearance of frost from the ground.

5th. Time of closing and opening of rivers, lakes, streams, &c., and any other phenomena relating to temperature.

A single register of any one of these phenomena carefully made,

may prove of great service in tracing the changes of weather over large districts of country; for example, a knowledge of the exact time at which a violent wind commences at a particular place may enable us, with similar observations at other localities, to trace the progress of the disturbance through its whole course from its beginning to its ending.

For more detailed instructions reference should be made to the accompanying blanks and pamphlets.

Of the blank registers two different classes are sent. Those marked No. 1 are intended to record observations with all the instruments, with spaces to include the reductions for "Force of Vapor" and "Relative Humidity," which need not be filled up unless the observer himself prefers to make the calculations, which will otherwise be made at the Institution.

Blanks No. 2 are intended for observers who have no instruments, excepting a thermometer; and if this instrument be broken, or the observer have none, valuable materials may still be furnished by filling up the other columns, and simply noting the beginning and ending of warm and cold spells.

In the accompanying package will also be found blanks for recording periodical phenomena of animal and vegetable life. Such records will be of especial interest, as showing the progress and development of the seasons, and the geographical distribution of species.

In the package will also be found detailed instrnctions in regard to the collecting and preparing objects of natural history. Specimens of the different animals will be particularly interesting, especially of the small mammals, as mice, moles, shrews, gophers, weasels, rabbits, ground squirrels, marmots, etc. Good skins and skulls of the barren ground bear, the musk ox, and the reindeer, are much wanted.

Attention is especially invited to the collecting of eggs of any and all kinds of the birds which may be met with. The species of most interest are the different eagles, hawks, and owls, snipes, sandpipers, plover, gulls, ducks, loons, grebes, etc. Care should be taken, as far as possible, to secure a parent bird of each set of eggs, for the purpose of identifying the species; either the entire skin being preserved, or at least the head, wing, and tail. If a parent cannot be obtained, the eggs should nevertheless be

collected, and any information communicated which may serve to determine the species.

Skins of any divers or grebes in full spring plumage, of the large black grouse, of the ptarmigan, or willow grouse (especially in summer dress), of the different kinds of Canada or black-necked geese, and of any waders in full breeding plumage, and in fact of Arctic birds generally, will be very acceptable.

The different species of Salmonidæ, as salmon, trout, whitefish, and grayling, are particularly desired by the Institution. In the absence of alcohol, these may be skinned and dried. Fishes of all kinds, however, will be much valued.

Insects of all kinds will be highly prized, and, in fact, no object of natural history, however abundant and familiar, will be without its interest to the Institution.

If suitable opportunities occur for the transmission of any returns to these circulars, either of specimens or of observations, they should be sent directly to the Smithsonian Institution, Washington, D. C.; if not, they should be forwarded to the care of the Governor of the Hon. Hudson's Bay Company.

JOSEPH HENRY,
Secretary S. I.

Smithsonian Institution, Washington, *April* 20, 1860.

APPENDIX.

Hudson's Bay House, Lachine, 31st March, 1860.

To the Officers of the Hudson's Bay Company's Service.

Gentlemen: Having been applied to by the Secretary of the Smithsonian Institution of Washington, for permission to invite the assistance of the Company's officers in conducting observations, having for their object the development of the physical and natural history of the northern part of this continent, I have very cheerfully acceded to the request, and take the present means of commending the object in view to your favorable consideration.

You are well aware of the desire of the Company to promote the interests of science by all the legitimate means in its power. In the present case, where so much may be done by systematic and conjoined action, over a widely extended territory, it will be gratifying to learn that information and materials of a valuable character have been supplied from the stations of the Company, and by the industry of its officers.

The accompanying circular and instructions, from Professor Henry, will explain more fully the objects of the Institution, and will be found to embrace all necessary information for your guidance.

I am, gentlemen,

Your obedient servant,

G. SIMPSON.

INSTRUCTIONS

IN REFERENCE TO

COLLECTING NESTS AND EGGS OF NORTH AMERICAN BIRDS.

INTRODUCTORY REMARKS.

The Smithsonian Institution is desirous of collecting as full a series as possible of the nests and eggs of birds of North America, with the view not only of exhibiting them in its museum, but also to serve as materials for a work on North American Oology, to be prepared by Dr. Brewer, of Boston, and published in successive parts by the Institution.

This memoir is intended to give an account of the geographical distribution of North American birds, as well as of their habits and peculiarities during the breeding season, and to be accompanied as far as possible by accurate figures of the principal varieties of the egg of each species, based upon photographic drawings. Of this work, the first part, embracing the *Raptores* (vultures, eagles, hawks, and owls), and *Fissirostres* (swallows, swifts, and goatsuckers), has already been published.

The object contemplated by the Institution is thus not merely to procure specimens of eggs not previously in its museum, but also to obtain positive evidence as to the limits within which each species rears its young. For this reason it respectfully invites donations from all parts of the country of as many kinds of nests and eggs as can be obtained, with the exception of a few of the very commonest species hereafter mentioned; and asks that especial attention may be directed toward making the collection as complete as possible for each locality. As duplicate eggs of all kinds, and in any number, can be readily used in the

exchanges of the Institution, and in supplying other cabinets, no fear need be entertained of sending more than enough for the purposes in view.

The eggs, of which a single set only need be collected for the present, are chiefly those of the eastern bluebird (*Sialia sialis*), the robin (*Turdus migratorius*), the cat-bird (*Mimus carolinensis*), the red-winged blackbird (*Agelaius phoeniceus*), and the crow blackbird (*Quiscalus versicolor*). Those to which particular attention should be paid as groups, are the eagles, hawks, owls, woodpeckers, small waders, ducks, &c., of all portions of the country; but, as stated, all kinds of eggs, and particularly those from the regions west of the Mississippi, and from the northern parts of America, are desired. A subjoined list embraces the species more particularly desired by the Institution; especially those having an asterisk prefixed, which are, with few exceptions, entirely unknown to science. The numbers in the list refer to a printed catalogue of North American birds, published by the Institution, which will be sent to any one who proposes to collect eggs for its museum.

The attention of collectors and correspondents is particularly invited to eggs of the following easily identified and well-known birds: The California condor or vulture (*Cathartes californianus*), and the golden or ring-tailed eagle (*Aquila canadensis*); the swallow-tailed hawk (*Nauclerus furcatus*), the black-shouldered hawk (*Elanus leucurus*), and the Mississippi kite (*Ictinia plumbea*), of the Southern States; the duck hawks (*Falco anatum*, etc.), and the speckled partridge hawk (*F. candicans*), of the North. All the black and other Rocky Mountain hawks; all the owls, especially those breeding in the North, as also the burrowing owls of the West; the ivory-billed woodpecker (*Picus principalis*), the red-shafted flicker of the West (*Colaptes mexicanus*), the Rocky Mountain bluebird (*Sialia arctica*); all the warblers; the Bohemian wax-wing (*Ampelis garrulus*), the violet green swallow (*Hirundo thalassina*); the black swifts or swallows of the Rocky Mountains and the Northwest; the Rocky Mountain wrens and nuthatches; the Canada, Steller's and Rocky Mountain jays generally, including the Piñolero; the band-tailed pigeon of the Rocky Mountains and West (*Columba fasciata*); the New Mexican and Rocky Mountain wild turkey (*Meleagris mexicana*); the dusky or black mountain grouse

(*Tetrao obscurus*); the spruce partridge (*Tetrao canadensis*), and all other grouse and pheasants; all the crested quails or partridges of Western Texas and New Mexico; the white prairie or whooping crane (*Grus americana*); the courlan, water hen, or crying bird of Florida (*Aramus giganteus*), all the snipes, sandpipers, plovers, curlews, ducks, geese, swans, gulls, and terns of the interior, as well as the different flycatchers, sparrows, etc.

The following details furnished by Dr. Brewer, are believed to contain the most important instructions necessary for the preparation and preservation of oological collections:—

INSTRUCTIONS FOR COLLECTING AND PRESERVING.

The nests of birds are to be sought for in all localities and in various months of the year according to the latitude, May and June being generally the most productive. Many of the rapacious birds, however, begin to lay much earlier in the middle States, even in February and March. This is especially the case with the bald eagle, great-horned owls, etc. Others again will be found breeding in July and August.

When a nest containing eggs, or one newly constructed, is discovered, it should not be disturbed, if possible, before the parents have been observed hovering around or near, and thus identified. If the species cannot be otherwise positively determined, and generally in any case, a parent bird should be secured, and either the whole skin be prepared, or a portion—as the head and wing—preserved for identification. The bird may also be thrown into alcohol, and thus easily kept.

The services of boys and other persons on farms, plantations, &c., may be called to great advantage into requisition in collecting eggs. Whenever they have found a nest, however, it should not be disturbed before information is communicated to, and the spot visited by some one competent to determine the species, unless the parents can be taken with the nest. No pains should be considered too great to secure the certain identification of each set of eggs. Horse-hair snares arranged about a nest will often secure the parent bird. If identification be impossible, however, the eggs should still be preserved, as the species can usually be approximated to, if not absolutely determined, by an expert oologist.

Sometimes by removing all the eggs in a nest, except one or two, without handling those left, quite a large number can be obtained from one pair of birds; generally, however, the nest will be found abandoned on a second visit.

The nests may not always be removable. In such cases, full mention of their position, character, &c., should be carefully made. Nests constructed in bushes or on trees usually need but slight precautions for their preservation intact. Those on the ground often require to be secured against dropping to pieces by a little judicious wrapping, or tying together, or even by a few coarse stitches with a thread and needle.

A little cotton packed in the nest above the eggs will generally keep the latter whole until reaching home, unless subjected to a violent shock. It will be safer, however, to inclose each one in an envelop of cotton.

It is absolutely necessary, in all cases, to empty every egg of its contents, in order to preserve the shell for cabinet purposes; and this should be done at the earliest moment possible. It is accomplished in various ways: the simplest, when the egg does not contain an embryo, being to prick a small aperture at each end, on opposite sides, with a sharp needle (a three-cornered one answers best), or an egg drill, one aperture rather the larger, through which the contents are blown by the application of the mouth at the other. Delicate eggs, however, when fresh, can be best emptied by suction, a small quantity at a time of the contents being drawn into the mouth, and then discharged. European collectors generally make two apertures near the extremities, that towards the blunt end the larger; or else a single hole in the side through which the contents are emptied by the blowpipe or syringe. This is much the better way, when a blowpipe can be procured.

Should there be an embryo in the egg, or should the contents have become thickened by long standing, it will be necessary to make a larger aperture in the side by cutting out a circular piece of shell carefully with the needle or drill. A smaller hole may then be made opposite to this, at which to apply the mouth in blowing, or the embryo may be picked out through a single large hole. It will be of much interest to preserve all embryos in alcohol for further investigation. The discharge of the contents of the egg is facilitated by the use of a small blow-

pipe or tube, the smaller end so fine as to enter the smaller aperture. A stream of water injected by the mouth through the tube into the aperture will be found an expeditious method of emptying the egg, but it must be conducted very carefully. When a large hole is made, the tube may be directed through it to the opposite side of the egg, and a current of water forced in this will soon discharge the contents. A syringe, with slender fine point, will be found an exceedingly convenient instrument, as a discharge of water through the pipe into the egg will empty it very rapidly, and serve to wash the inside afterwards. Great care must, however, be exercised not to use much force or haste in this, as there is much danger of bursting the egg. When practicable, the white membrane, the edge of which usually protrudes from the opening after the liquids are forced out, should be seized with a pair of forceps and pulled out, as, if left, it may discolor the egg, and will always attract insects. If not too small, the egg should then be partly filled with water, by means of the tube or syringe (or by laying one hole against a saucer of water and sucking through the other), and carefully rinsed out. After the water is again blown out, the egg may be allowed to dry by placing the larger hole downwards on blotting or absorbent paper or cloth. When dry, the eggs should be replaced in the nest, or laid carefully away, care being taken to add a number or other mark showing the locality, position of the nest, whether on the ground, or in a bush or tree, etc., date, collector, and supposed species, as well as relationship to an embryo removed, or to any portion of the parent preserved. It will in most cases be best to give exactly the same number to nest, eggs, embryo, and parent belonging together. This mark may be made neatly on the eggs (best with ink and a quill pen). A record book showing what has been taken and preserved, with dates and explanatory remarks, should always be kept.

In making the apertures in eggs that have peculiar markings, care should be taken to select some inconspicuous spot that will leave the pattern of coloration undisturbed. Eggs that are cracked may be greatly strengthened by pasting tissue or other thin paper along the line of injury, or what is easier, and in most cases even better, by brushing collodion along and over the cracks. It is often well to cover the punctures or holes cut

out, especially if large, with thin paper or silk or goldbeaters' skin. If a piece be removed, it can usually be easily replaced and kept in by pasting thin paper over it and the line of separation, or around the latter.

Notwithstanding the apparent fragility of eggs, a very little experience will enable any one to empty them of their contents with great ease and safety. The principal accident to be guarded against is that of crushing the egg by too great pressure between the fingers; these should be applied so as to barely hold the egg, and no more. If the operation of emptying be performed over a full basin of water, the occasional dropping of the egg from the finger into the water will be attended with no harm.

To pack eggs for transportation, each one should be wrapped in a light envelop of cotton and laid down in layers separated by strata of cotton. They should be kept in rather small boxes of wood, or if pasteboard be used, these should always be transmitted in wooden boxes, as the eggs are thereby less likely to be broken by a sudden jar or shock. If the nest is sent along, it may contain the eggs belonging to it, each one wrapped in cotton, and the vacancy of the nest filled with the same or other light elastic material. It will be well to pin or tie up each nest in paper to keep it secure, and to prevent entangling of the materials when several are laid together. A temporary box may often be readily constructed of pasteboard, to contain the more delicate or valuable ones.

Whenever practicable, the embryos or young found in the egg should be carefully preserved in alcohol, great care being, of course, taken to mark the specimens properly. The better plan will be to keep each set in a small bottle or vial, and a slip of stiff paper or parchment placed inside with the number or name. Whenever the abundance of the eggs will authorize it, a large number with the young in different degrees of development, even as many as fifty of a kind, should be secured. The embryos in this case need not be removed from the egg, which should, however, be cracked at the blunt end to facilitate the entrance of the spirit. Researches at present in progress relating to the embryology of birds promise results of the highest importance in reference to ornithological classification.

In addition to the nests and eggs of North American birds, skins of some species are wanted by the Smithsonian Institution

for the completion of its ornithological museum, by filling up gaps in the series or by replacing imperfect specimens. Among the large groups of birds, to which attention is invited, are the wandering oceanic species of both the Atlantic and Pacific coasts, such as petrels, shearwaters, guillemots, Mother Carey's chickens, jagers, gulls, terns, etc.; together with the cormorants and grebes, or divers, in their full breeding plumage, as ornamented with linear white feathers, crests, ruffs, etc.

The species of birds most wanted from particular regions are, among others, the following:—

From Florida and the Southeastern U. S.—The flamingo, pink curlew, scarlet ibis, small black hawk (*Rosthramus sociabilis*), a vulture or turkey buzzard with white markings, a blue heron of the largest size with white crest (*Ardea wurdemanni*), the large Florida crow, the small blue jay, etc.

From Texas and New Mexico—Any of the summer resident birds, especially those found on or near the Rio Grande, with their eggs; jays, thrushes, doves, hawks, owls, orioles, blackbirds, crows, quails or partridges, the large white whooping or prairie crane (*Grus americana*), etc.

From the Rocky Mountain Regions.—The wild turkey with whitish margin to the feathers of the rump and tail (*Meleagris mexicana*); all the different jays, grouse, pheasants, woodpeckers, black swallows, with or without white throats; the hawks, especially the large black ones.

From the Interior and Northern Portions of the Continent.—The white crane already mentioned, the small geese, the large Canada goose with white extending from the collar down the throat (*Bernicla leucolæma*), the larger trumpeter swan, the rosy gull with black head (*Larus franklinii*), and any other gulls and terns; the white and speckled hawks of the arctic regions, etc.

From the Pacific Coast.—The large California vulture or condor, any hawks, geese, terns, thrushes, magpies, the black oyster catcher, etc.

A pamphlet containing the necessary instructions for preserving birds will be forwarded to any one desiring it, upon application.

JOSEPH HENRY, *Secretary S. I.*

Smithsonian Institution, *Jan.* 1, 1860.

SPECIAL DESIDERATA AMONG THE EGGS OF NORTH AMERICAN BIRDS.

N. B.—The asterisk (*) prefixed indicates that the egg of the species is either entirely unknown to science, or scarcely to be found in any American collection. The numbers are those of the species in the catalogue of North American Birds, published by the Smithsonian Institution, reprinted from the ninth volume of the Pacific Railroad Reports. Many species, however, not entered in this list are wanting in the Smithsonian collection.

*2	52	*104	165	*211	*274	*323	381	*442	503	*564	*614	*669
*4	*53	*107	166	*212	275	324	382	*443	*505	*565	*618	*670
5	54	*108	168	213	*273	*327	*383	*444	*509	*566	*621	*671
*6	*55	*110	*169	214	*276	*329	385	*445	*510	567	*622	*673
7	*56	113	*171	*215	278	*330	388	446	*511	*568	*625	*674
*8	57	*115	*172	*216	280	*331	389	447	*513	*569	626	*675
9	*58	118	*173	*218	*281	*333	*392	448	515	*570	627	*676
*10	59	*119	*174	*219	*283	*334	*393	449	*516	*571	629	*677
*11	*60	*120	175	221	*284	335	*394	450	520	*572	*630	*678
12	*61	*121	178	*222	*285	336	*395	*452	521	*573	*631	*679
14	*62	*122	179	*223	*286	339	397	*454	523	*575	*632	680
*16	63	125	180	*224	*287	*340	398	455	*524	578	*633	*684
18	*64	*127	181	228	*288	341	402	*458	*525	579	*634	*686
*19	*65	*128	*182	*232	*289	*343	403	459	*526	582	635	*687
20	66	*129	183	234	*291	*345	404	460	*527	583	*636	*691
*21	67	*132	184	*235	*292	346	405	*461	528	584	*637	*693
*22	71	*133	*185	236	293	*347	408	462	*529	*585	*638	*700
23	*72	134	187	239	*294	*348	409	463	530	*588	*639	*702
24	*73	*136	*188	*241	*295	*350	410	*466	*531	*589	640	*704
25	*75	137	189	*242	*297	*351	411	467	*532	*590	*641	*705
*26	*77	138	*190	*243	298	*352	412	468	*533	*591	*643	*707
27	*78	*141	*191	*244	*299	*353	413	*469	*534	*592	*644	*710
*28	*80	*142	*192	246	300	*355	*417	470	*535	*593	*646	*714
*29	81	144	193	247	*301	*356	422	473	*536	*594	647	*716
30	*82	145	194	*249	*303	*360	423	*475	*538	*595	648	*717
31	*83	*146	*195	250	*304	*361	*424	*476	*539	*596	*650	*718
*32	*84	*147	196	251	*306	*362	425	*477	540	*598	651	*720
*33	*86	149	*197	255	307	364	*427	*478	541	*599	652	*721
*34	*87	*150	198	256	*310	*365	428	479	*542	*600	*653	*722
*35	*88	151	*199	257	*311	*366	*430	*480	546	*601	*654	*723
*36	*89	*152	200	258	*312	367	*431	*481	*547	*602	*655	*724
*37	90	153	*201	262	314	*370	432	*482	*548	*603	656	*725
*39	*91	*154	202	*263	*315	*371	*433	*488	549	*604	*657	*728
*40	92	*156	204	*264	316	*372	435	489	*550	*605	658	732
*41	*93	*159	*205	*266	317	*373	*436	*494	*551	*607	*659	*733
42	95	160	*206	267	318	*374	437	497	556	608	*663	*734
47	*96	*161	*207	269	319	375	*438	498	*557	609	*664	*735
48	*98	*162	208	271	320	376	439	*500	*561	610	*665	*736
49	*99	*163	*209	272	321	*379	*440	501	*562	611	666	*737
50	*100	*164	210	273	*322	380	*441	502	*563	613	*668	738
51	*103											

APPENDIX.

Since the preceding pages were set in type an article has been received from Mr. Alfred Newton, an eminent English oologist, detailing the elaborate methods employed by English collectors of much experience in emptying and preparing eggs for the cabinet. As these methods involve the use of more or less complicated apparatus, which will not be generally procurable by the correspondents of the Institution, the new instructions are commended particularly to the use of those who are forming cabinets for themselves, and are willing to give the time and attention required. All correspondents who propose to collect eggs for the Institution are, however, requested to read carefully Mr. Newton's instructions, and to adopt his suggestions as far as practicable.

JOSEPH HENRY,
Secretary S. I.

SUGGESTIONS

FOR FORMING

COLLECTIONS OF BIRDS' EGGS.

BY ALFRED NEWTON.

GENERAL REMARKS.

The collecting of birds' eggs for scientific purposes requires far more discrimination than the collecting of specimens in almost any other branch of natural history. While the botanist, and, generally speaking, the zoologist, at home is satisfied as long as he receives the specimens in good condition, with labels attached giving a few concise particulars of when and where they were obtained, it should be always borne in mind that to the oologist such facts, and even the specimens themselves, are of very slight value unless accompanied by a statement of other circumstances which will carry conviction that the species to which the eggs belong has been accurately identified, and the specimens subsequently carefully authenticated. Consequently precision in the identification of his specimens should be the principal object of an egg-collector, to attain which all others must give way. There are perhaps few districts in the world, and certainly no regions of any extent, whose faunas are so well known that the most rigid identification may be dispensed with. Next to identifying his specimens, the most important duty of an egg-collector is to authenticate them by marking them in some manner and on some regular system as will leave no doubt, as long as they exist, of their having been obtained by him, and of the degree of identification to which they were subjected. Neatness in the mode of emptying the shells of their contents, and other similar matters, are much to be commended; they

render the specimens more fitted for the cabinet. But the main points to be attended to, as being those by which science can alone be benefited, are IDENTIFICATION and AUTHENTICATION.

IDENTIFICATION.

Of course the most satisfactory, and often the simplest, way of identifying the species to which a nest of eggs, when found, belongs, is to obtain one of the parents, by shooting, snaring, or trapping. But it sometimes, in practice, happens that this is found to be difficult, from one cause or another—such as the wary instincts of the birds, or the necessities of his position compelling the traveller to lose no time, or the scarcity of the species making him unwilling to destroy the individuals. In any of these cases there is nothing to be done but to make as careful an examination as circumstances will admit of the precise situation of the nest, the materials of which it is composed (supposing that the collector cannot bring it away with him), and accurately to survey the surrounding locality, to observe by what species it is frequented; all the particulars of which examination and survey should be fully noted down at the earliest opportunity possible. Should, however, either or both the birds be killed, they should be skinned, or at least some characteristic part of each preserved,[1] and duly labelled to correspond with the inscriptions subsequently put on the eggs, and *always* with a reference to the collector's journal or note-book, wherein fuller details may be found.

The oologist is especially warned not to be misled by the mere fact of seeing birds around or near the nests. Many of the crow family (*Corvidæ*) are great eaters of eggs, and mistakes are known to have originated from birds of that kind being seen near nests of which they were certainly not the owners. Others, such as the titmice (*Paridæ*), though not plunderers, obtain their food by incessantly seeking it even in the very localities where many

[1] Birds may be preserved *entire* by simply pouring (through a small funnel) a few drops of *pyroligneous acid* down their throats, and saturating the feathers, especially about the vent, with the same fluid; after leaving them to dry for an hour or so, they may be wrapped in paper and packed. (Communicated by Mr. John Hancock.)

species build. It often happens, also, that two different birds have their nests situated very close to one another; and if they be allied species, the collector may be easily deceived. Thus, it has come to the writer's knowledge that the dunlin (*Tringa alpina*) and the purple sandpiper (*Tringa maritima*) have had their nests only a few feet apart. At first a pair of the latter only were seen, which by their actions betrayed their uneasiness. A short search discovered a nest with four eggs. The observer was one of the best practical oologists then living, and his eye at once saw that it was not the nest which he wanted; but a less experienced man would doubtless have immediately concluded that he had found the eggs of the rarer species. Indeed it may, generally speaking, be said of most birds, that whenever they have nests of their own they are also acquainted with those of their neighbors, which by their actions they will often betray to the collector who may be patiently watching them. Birds, again, will occasionally lay their eggs—accidentally, as it were—in the nests of other species, even when they are not of a parasitic nature, as the Old World cuckoos (*Cuculus, Eudynamis*, and *Oxylophus*), or the cow blackbird (*Molothrus pecoris*); thus eggs of the eider duck (*Somateria mollissima*) have been found in the nest of a gull (*Larus*), and other similar cases are on record, in some of which, from the species being nearly allied, confusion might easily have arisen, though at the time no doubt may have occurred in the collector's mind.

It would be impossible in this paper to treat of the various methods which may be successfully employed to obtain the birds to whom a nest belongs, and, in fact, these methods can generally be only learned by experience. It is sufficient to indicate here the use of traps, snares, hingles, or bird-lime, in cases where the individuals are too shy to admit of being shot by the gun or rifle. Much may often be gathered by the collector from the practice of the natives, especially if they be savages, or half civilized. In like manner it would too much extend these suggestions to give a detailed account of the different ways in which the nests of birds are to be found. The experience of a single season is to most men worth a whole volume that might be written on the subject. Nevertheless, a few hints are given further on, which might not occur to the beginner.

AUTHENTICATION.

The most complete method of authenticating eggs is that of writing in ink on their shells, not only the name of the species to which each belongs, but also, as far as the space will admit, as many particulars relating to the amount of identification to which the specimen was subjected, the locality where, date when, and name of the person by whom they were taken, *adding always* a reference to the journal or note-book of the collector, wherein *fuller details* may be given. It is advisable to do this on some regular system, and the following method is suggested as one that has already been found to work well in practice. The *scientific* names *only* to be used, except with a mark of doubt or within brackets, when the specimens have *really been satisfactorily identified;* and if the identification has been made by obtaining one or both of the parent birds, a memorandum of the fact to be added, thus: "Both birds snared;" "Bird shot;" or, in smaller space, "Bd. st." If the identification has been effected only by obtaining a good view of the birds, the fact should be stated thus: "Bird well seen," "Bird seen," or "Bd. sn.," as the case may be. For eggs not taken by the collector himself, but brought in by natives, or persons not having a scientific knowledge of ornithology, the *local name* or the *name applied by the finder* should *only* be used, unless indeed it requires interpretation, when the scientific name may be added, but *always within* brackets, thus: "Tooglee-aiah (*Squatarola helvetica*);" the necessary particulars relating to the capture and identification being added. Eggs found by the collector, and *not* identified by him, but the origin of which he has reason to think he knows, may be inscribed with the common English name of the species to which he refers them; or if it has no such appellation, then the scientific name may be used, but in that case *always with a note of interrogation* (?) after it, *or else* the words "Not identified." If the collector prefers it, many of these particulars may be inscribed symbolically or in short-hand, but *never unless* the system used has previously been agreed upon with persons at home, and it be known that they have a key to it. *Each specimen should bear an inscription;* those from the same nest may be inscribed identically; but different nests, especially of the

same or nearly allied species, should never be so marked that confusion can possibly arise. It is desirable to mark temporarily with a *pencil* each egg as it is obtained; but the permanent inscription, which should always be in ink, should be deferred until after the egg has been emptied. The number terminating the inscription in all cases referring to the page of the collector's note-book, wherein full details will be found, and the words or letters preceding the number serving to distinguish between different collectors, no two of whom ought to employ the same. (The initial letter of the collector's name, prefixed to the number, will often be sufficient.)

PREPARATION OF SPECIMENS.

Eggs are emptied, with the least amount of trouble, at *one* hole, which should be drilled in the *side* with such an instrument as shown in the sketches (*figs.* 1, 2, and 3).[1] The hole should, of course, be proportioned to the size of the egg, and the amount of incubation it has undergone. Eggs that are hard sat upon are more easily blown by being kept a few days, but the operation must not be deferred too long, or they are apt to burst violently immediately on being punctured, though this may be avoided by holding them under water while the first incision is made. The hole being drilled, the lining membrane should be cleared away from the orifice with a penknife (*fig.* 14), by which means not only is the removal of the contents, but also the subsequent cleansing of the specimen, facilitated. The small end of a blowpipe (*figs.* 4 and 5) should then be introduced, while the other extremity is applied to the mouth, and blown through, *at first very gently*. If the embryo is found to be moderately developed, a stream of water should be introduced by means of a syringe (*fig.* 7), and the egg then gently shaken, after which the blowpipe may be again resorted to, until by the ultimate use of both instruments, aided by scissors (*figs.* 8 and 9), hooks (*figs.* 10, 11, and 12), knives (*figs.* 13, 14, and 15), and forceps (*fig.*

[1] The great object to be attained is the formation of a *circular* hole with *smooth edges*. Collectors not having such a drill as is here recommended, will find a common *nail* or a three-cornered needle a useful substitute, but they must be used with extreme care.

16), the contents are completely emptied. After this the egg should be filled with water from the syringe, gently shaken, and blown out, which process is to be repeated until its interior is completely cleansed, when it should be laid upon a pad of blotting-paper or fine cloth, with the hole downwards, its position on the pad or cloth being occasionally changed, until it is perfectly dry. During this time it should be kept as much as possible from the light, especially from the sunshine, as the colors are then more liable to fade than at any subsequent time. In the case of very small eggs, when fresh, the contents may be sucked out by means of a bulbed tube (*fig.* 6), and the interior afterwards rinsed out as before. It is always advisable, as far as possible, to avoid wetting the outside of the shell, as the action of water is apt to remove the "bloom," affect the color, and in some cases alter the crystallization of the shell. Consequently dirt stains or dung spots should never be removed. While emptying the contents, it is as well to hold the egg over a basin of water, to avoid breakage in case of its slipping from the fingers. Eggs that are very hard sat upon, of whatever size they be, should be treated in the manner detailed in the accompanying "Description of Egg-blowing Instruments," under the head of "*fig.* 17," which is a method superior to any other known at present to the writer for preventing injury arising to them. Should the yelk of the egg be dried up, a small portion of *carbonate of soda* may be introduced (but with great care that it does not touch the outer surface of the shell, in which case the color is likely to be affected), and then the egg filled with water from the syringe, and left to stand a few hours with the hole uppermost, after which the contents are found to be soluble, and are easily removed by the blowpipe, assisted by one of the hooks. It is almost unnecessary to add, except for the benefit of beginners, that the manipulation of the different instruments requires extreme caution, but a few trials will give the collector the practice necessary for success. Those who may still prefer to blow eggs by means of *two* holes are *particularly requested not to make them at the ends of the eggs, nor at opposite sides*, but on the same side. (*fig.* 18.) In this case the hole nearest the smaller end of the egg should be the smallest, and the contents blown out at the other. If the holes are made at the *ends* of the eggs, it not only very much injures their appearance as cabinet specimens,

but also prevents their exact dimensions from being ascertained accurately; and if they are made at *opposite sides*, the extent of the "show surface" is thereby lessened. Eggs should never be written on until the shells are perfectly dry, or the ink will be found to run, and the inscription will be rendered illegible. Eggs with chalky shells, such as those of the anis (*Crotophaga*), gannets and cormorants (*Pelecanidæ*), and others, may be conveniently marked by incising with a pin or the point of an egg-drill, so also those of the ptarmigans (*Lagopus*), care being taken in this case to select the dark-colored patches to write upon. The inscriptions should always be placed on the same side as the hole or holes, and confined within the smallest limits possible. For drilling the hole or holes the side presenting the least characteristic markings should be selected.

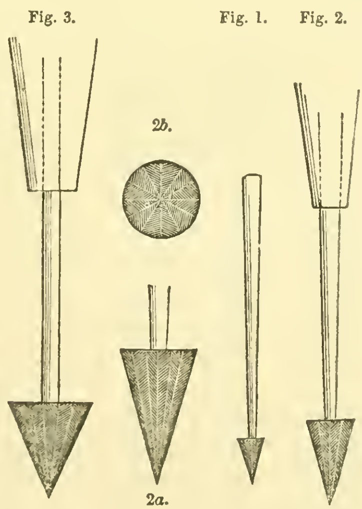
CONCLUDING OBSERVATIONS.

The best allies of the collector are the residents in the country, whether aboriginal or settlers, and with them he should always endeavor to cultivate a close intimacy, which may be assisted by the offer of small rewards for the discovery of nests or eggs. He should, however, always insist upon any nests found being shown to him *in situ*, and the gratuities paid should be proportioned to his success in identifying the species to which they belong. He should steadily refuse any but the most trifling remuneration for nests or eggs taken and brought to him. As a rule, the eggs of the different species of plovers and sandpipers (*Charadriadæ* and *Scolopacidæ*) are those most wanted by oologists of all countries. These birds mostly breed in high northern latitudes, but they often choose elevated spots for nesting in more southern parallels. Their nests are nearly always difficult to find, even when the birds are discovered. Their habit is, if the ground be at all rough with herbage, to run off the nest for some distance before taking wing, as the observer approaches; if the ground be bare, they will try to escape observation by squatting closely until they are almost trodden upon. The best method of finding them, and indeed the nests of some other species, is for the collector to conceal himself near the place where he has reason to believe the eggs are, and to endeavor to watch the bird as she returns to her nest—using a telescope, if neces-

sary; but should this fail, after giving her time to settle herself upon it, to fire off a gun suddenly, or spring up and shout, when the bird, in her surprise, will often at once take wing from the nest, or at least without running many yards. To reach the nests of rock-building birds, a man or boy can be lowered by a rope from the top, when it is accessible. The rope should *always be tied under the arms* of the person lowered, as substances, detached from above by the friction of the rope, may, by falling on him, stun him for a moment, and cause him to lose his hold. But in all places and at all times an egg-collector should recollect that IDENTIFICATION and AUTHENTICATION are his *main objects, to attain which no trouble is too laborious, no care too great.*

DESCRIPTION OF EGG-BLOWING IMPLEMENTS.

Figs. 1, 2, and 3, represent "drills" for making neat and circular holes in the shell. These drills should be made of the best



Figs. 1, 2, 3, natural size. Figures 2*a*, 2*b*, enlarged

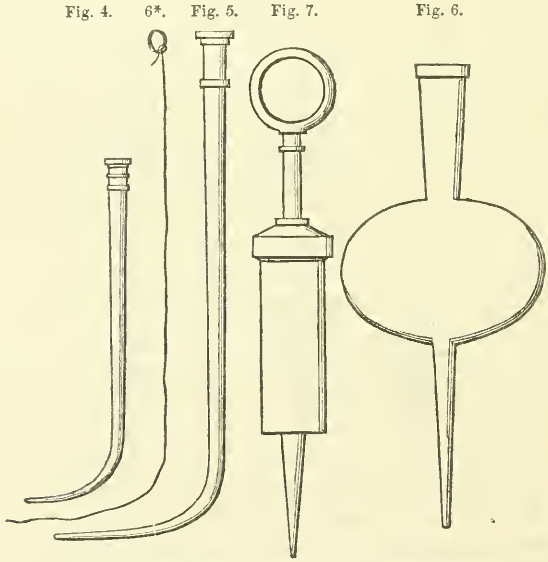
steel that can be procured, and of different sizes. *Fig.* 1 is meant for the smallest eggs, even humming bird's, up to those

say of a robin (*Turdus migratorius*). The grooves forming the drilled surface should be cut with a *chisel*. *Fig.* 2 will suit the generality of eggs, excepting those of very large birds and of sea fowl, which usually lay eggs with a strong but soft shell. The grooves may be cut either with a *chisel* or a *file*, but if with the latter, greater care will be requisite in its use. *Fig.* 3 is intended for the largest eggs, and even some of the smaller ones which have a chalky shell, such as *Crotophaga*. The grooves are cut with a *file*. In the manufacture of all these drills the greatest care is necessary that the grooves should lie *parallel to one another*, and that their *edges should be smooth*. The smaller the drill, the more acute should be the angle it forms at the point. The drills may be fitted with handles or not according to fancy. Those with handles are less likely than the others to cramp the fingers of the performer, an inconvenience which often causes breakages.

N. B. A separate sketch is given with the *enlarged* views of the end of a drill, in order to show more plainly the manner in which the grooves should be cut.

Figs. 4 and 5 represent blowpipes, for emptying eggs. They

Fig. 4. 6*. Fig. 5. Fig. 7. Fig. 6.



Half natural size. Natural size.

are best made of metal, and for this purpose nickel (or German silver) is preferable, as being less liable to rust. A collector should have two sizes, as a large size is not convenient for small eggs, and a small one causes loss of time in blowing large eggs. They should be made as light as possible, or they may slip from the mouth and break the egg being operated on. The chief point to be attended to in their construction, is that the lower orifice should be as *large* as the size of the pipe permits. It is of course necessary that they should be perfectly smooth outside, towards the lower end. They may be straight, although the curve is preferable.

Fig. 6 represents a tube for emptying small eggs by suction. The bulb is to receive the contents of the egg and prevent them from reaching the mouth of the operator and thus causing nausea. This instrument is best made of thin glass, as thereby it can be easily kept clean. The same remark applies to this as to the last, with respect to the size of the lower orifice.

N. B. A piece of thin wire (*fig.* 6*), long enough to pass entirely through the tubes, should be always kept at hand by the operator, to remove obstructions which are likely to occur from small pieces of the embryo, or half-dried yelk, being accidentally drawn into the tubes or blowpipes.

Fig. 7 represents a syringe, which will be found useful in rinsing out the inside of an egg. It may be made of any metal, though the pewter ones are apt, from their weight, to be clumsy. Nickel is recommended, as for the common blowpipes. The lower orifice should be as large as possible. The ring at the top should be large enough for the insertion of the operator's right thumb—as it must be remembered that he has to work it with one hand. The nozzle, as shown in the figure, is rather too tapering. It should be smaller in proportion at the upper end.

Figs. 8 and 9 represent scissors of shapes likely to be found very useful. *Fig.* 8 for cutting through the bones of the embryo *before it is extracted,* and *fig.* 9, for cutting off portions of it, *while it is being extracted* by one of the hooks represented in—

Figs. 10, 11, and 12, which should vary in size from that of an ordinary pin to that of stout wire. The length of their straight portions should be rather more than the diameter of the egg they are used on.

Fig. 13 represents a knife with a crooked blade, somewhat like a bill-hook, and may be useful in cutting up the embryo prior to extraction.

Figs. 14 and 15 represent a penknife and scalpel with elongated blades, or shafts, to admit of their being introduced into

Fig. 12. Fig. 11. Fig. 13.

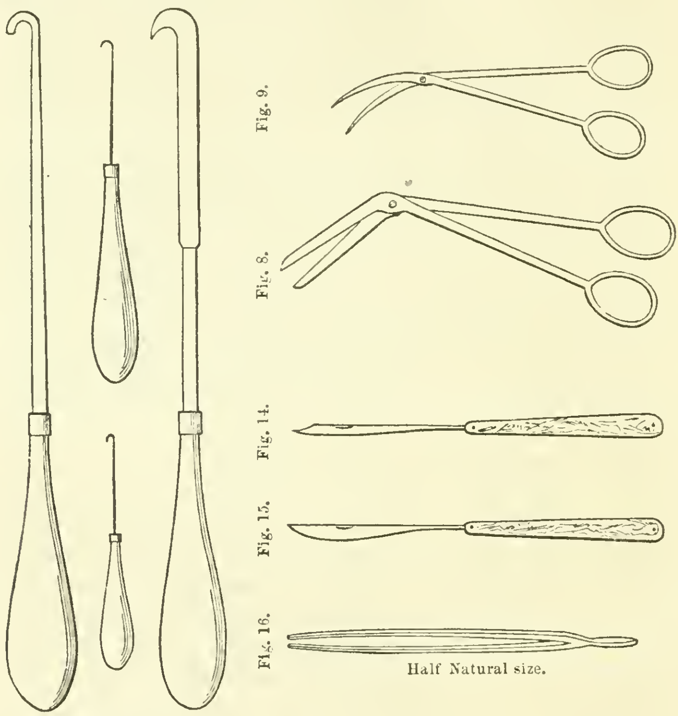


Fig. 9. Fig. 8. Fig. 14. Fig. 15. Fig. 16.

Half Natural size.

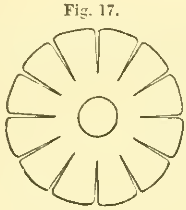
Fig. 10.
Natural size.

the egg to cut up the embryo. *Fig.* 14 is also, perhaps, the best instrument with which to remove the lining membrane from the hole. This is done by inserting the blade perpendicularly and slightly scraping the edge of the hole, as soon as it is drilled.

Fig. 16 represents a forceps for extracting the pieces of the embryo when cut up. The spring should not be too lively, as its resiliency may occasion breakage. The grasping surfaces should be *roughed* to prevent the pieces slipping.

Fig. 17 shows a piece of paper, a number of which when gummed on to an egg, one over the other, *and left to dry*, strengthen the shell in such a manner that the instruments above described can be introduced through the aperture in the middle and worked to the best advantage, and thus a fully formed embryo may be cut up, and the pieces extracted through a very moderately sized hole; the number of thicknesses required depends of course greatly upon the size of the egg, the length of time it has been incubated, and the stoutness of the shell and the paper. Five or six is the least number that it is safe to use.

Fig. 17.



Natural size.

Fig. 18.

Each piece should be left to dry before the next is gummed on. The slits in the margin cause them to set pretty smoothly, which will be found very desirable; the aperture in the middle of each may be cut out first, or the whole series of layers may be drilled through when the hole is made in the egg. For convenience sake the papers may be prepared already gummed, and moistened when put on (in the same way that adhesive postage labels are used). Doubtless, patches of linen or cotton cloth would answer equally well. When the operation is over, a slight application of water (especially if warm), through the syringe, will loosen them so that they can be easily removed, and they can be separated from one another and dried to serve another time. The size represented in the sketch, is that suitable for an egg of moderate dimension, such as that of a common fowl.

Observations —The most effectual way of adopting this method of emptying eggs, is by using *very many layers of thin paper and plenty of thick gum*, but this is of course the most tedious. Nevertheless, it is quite worth the trouble in the case of really rare specimens, and they will be none the worse for operating upon from the delay of a few days, caused by waiting for the

gum to dry and harden. The naturalist to whom this method first occurred, has found it answer remarkably well in every case that it has been used, from the egg of an eagle to that of a humming bird, and among English oologists it has been generally adopted.

CIRCULAR

IN REFERENCE TO THE

HISTORY OF NORTH AMERICAN GRASSHOPPERS.

The Smithsonian Institution, being desirous of obtaining accurate information respecting the Grasshopper[1] tribes of North America, calls the attention of its friends and correspondents to a number of queries relative to this subject, drawn up by Mr. P. R. Uhler.

It is well known that these insects destroy immense quantities of the products of the fields; while there is scarcely a plant that is not at times subjected to their ravages.

With these facts in view, and in consideration of the want of material to complete their history, the Institution respectfully requests attention to the subjoined questions. Answers may be returned by reference merely to the numbers.

Should there be several species of grasshoppers committing their depredations in any one locality, the queries should be answered separately for each.

In all cases, whenever practicable, full series of each species observed should be collected and preserved in a bottle or vial filled with alcohol, or strong spirit of some kind. If this cannot be obtained, the grasshoppers may be dried. Care should be taken to indicate the locality, date, and collector of each series. These may be transmitted to the Institution by any convenient opportunity. The answers to the queries may be sent to the Institution, either direct or under cover to the U. S. Commissioner of Patents.

[1] The grasshoppers of North America correspond to the locusts of the old world, which commit such ravages in Asia and Africa. The term locust is applied in America to a widely different insect, not here under consideration.

1. When does the Grasshopper lay its eggs?
2. How does it lay its eggs? With the ovipositor projected at the time into the ground, or into a hole dug beforehand?
3. At what depth does the female deposit her eggs?
4. What kind of soil does she prefer for this purpose?
5. What localities, whether near streams, on hill-sides, in pits, or in cavities?
6. How often does she lay her eggs?
7. How long does she live after laying them?
8. Does she lay them singly or in clusters?
9. Does she sometimes lay them singly, and at other times in clusters?
10. What do the eggs resemble?
11. What is their size? shape? color? markings?
12. How much time is occupied in laying the eggs?
13. What changes take place in the egg before it is hatched?
14. How long does the egg remain before it is hatched?
15. What state of the atmosphere is most favorable for its development?
16. How does the young escape from the egg?
17. What is its appearance? marking? size?
18. What places and food does it prefer?
19. Is it capable of producing noise, and how?
20. What is its general manner of life?
21. Does it exhibit any peculiar actions?
22. Is it ever pugnacious, or destructive of its own or other kind of insects?
23. When does its first change of skin occur?
24. What peculiarities does it then exhibit?
25. How long a time is occupied in changing the skin?

26. How many changes of the skin occur?

27. What are its peculiarities after each change?

28. What length of time between each change?

29. How long after its exclusion from the egg does its last moult occur?

30. What is the appearance of the pupa?

31. Does it change its skin?

32. When and how often does it moult?

33. Does it ever feed while moulting?

34. Does it change its food after moulting?

35. What changes take place in its habits or manners?

36. What remarkable appearance does it ever present?

37. When does it become full winged?

38. Does it ever moult after becoming full winged?

39. What changes in habits or manners then occur?

40. What comparative difference is there in the sizes of the sexes?

41. When does the male unite, sexually, with the female?

42. What is the length of time required for the act?

43. What peculiarities are observed at this time?

44. How much time elapses between this act and the laying of the eggs?

45. How long does the male live after the act?

46. How long does the female live after laying the eggs?

47. Does the female ever make a noise, and how?

48. How does the male produce his note?

49. At what times is he most noisy?

50. What variations of instinct have been remarked in either sex?

51. What condition of the atmosphere seems most favorable for their increase?

52. What other physical conditions favor them?
53. What physical conditions are most unfavorable to them?
54. What physical or other conditions cause them to migrate?
55. How far has their migratory flight been known to extend?
56. What times do they prefer for migrating?
57. What vegetable or other substances are repugnant to them and what do they prefer?
58. Do odors of any kind affect them in any particular way?
59. Through how extended a district have their ravages been noticed?
60. What remedies have been used to prevent their ravages?
61. How far has each remedy been successful?

A very small amount of time appropriated to observing these insects may bring about results of the most weighty importance. It is useless to attempt to prevent the destruction occasioned by any species of insect until a sufficient acquaintance with its economy is effected, and it is matter of much regret that, generally, so little is known respecting the insects of this country; a little exertion, well directed, will do much in obtaining correct information respecting them, and millions of dollars' worth of property be saved to the agriculturist every year.

Hoping that the zeal which has been so often displayed by the coadjutors of the Institution, in other departments of science, may be awakened in behalf of the important subject here presented, it makes this appeal, feeling assured that the assistance so much needed will be freely afforded.

JOSEPH HENRY,
Secretary of the Smithsonian Institution.

SMITHSONIAN INSTITUTION, *January* 1, 1860.

CIRCULAR

IN REFERENCE TO COLLECTING

NORTH AMERICAN SHELLS.

THE Smithsonian Institution contemplates the preparation of a series of Reports upon the Shells of North America, with particular reference to their geographical distribution; and takes this occasion to invite the coöperation of its correspondents and the friends of science generally, in collecting materials for this purpose, as well as in completing the conchological department of its museum and furnishing materials for its home and foreign exchanges. Due acknowledgment will be made for any such assistance, and a copy of the Reports presented to contributors, as well as a labelled series of their specimens returned, if desired.

The Institution is desirous to receive even the commonest shells, and in large numbers, for the purposes of exchange.

Any collections of shells or other objects of Natural History may be sent to the care of the Adams Express Company in the eastern part of the continent, and on the west coast to the care of Forbes & Babcock, San Francisco, Cal., by whom they will be forwarded to the Institution.

The following instructions based upon the experience of several practised collectors, have been presented to the Smithsonian Institution as containing the information necessary to attain the object in view.

JOSEPH HENRY, *Secretary S. I.*

SMITHSONIAN INSTITUTION, Jan. 1st, 1860.

SPECIAL INSTRUCTIONS.

The shells most wanted for the purposes in view are, in the first place, all the species of the western portion of the continent, the land and freshwater, and especially the marine shells of the Pacific; next the marine shells of the eastern coast, and of the Gulf of Mexico, including the West India Islands; next the land and freshwater univalves generally, with the *Cycladidæ;* and lastly, as best known, the *Unionidæ* or Mussels, especially those of the regions west of the Mississippi, and the southern Atlantic and Gulf States.

Wherever practicable, a full series of the shells of each locality, with their animals enclosed, should be preserved in alcohol; in the case of the smaller species, it will be well to throw in spirit all that can be collected, as much trouble in cleaning will thereby be saved. Shells with their animals are of much more value for scientific investigations than those without them, and should be carefully sought after. Dead shells, however, or those picked up on the beach or elsewhere, without any animal attached or included, should also be collected in large numbers, even when the same kinds are preserved in alcohol, as showing forms or variations not seen in the other series, or as increasing the aggregate of material for the investigation of the species.

As a general rule, the alcohol used should not be very strong—about fourth proof is the best. The shells, especially the diminutive ones, should be kept in small lots, and not mixed with vertebrates or crustaceans (which require stronger spirit), if it can be avoided. Small bottles, jars, or tin cans may be employed for the purpose. Shells without their animals should be preserved dry, and not thrown into spirit.

In packing shells for transportation, care should be taken to have the bottle or box in which they are contained perfectly full, to prevent friction during transportation. The larger ones should be wrapped separately in paper.

When it is inconvenient to transport shells containing their animals in alcohol, after having been immersed in this fluid, they may be taken out and the animals allowed to dry up. They can at any time be relaxed again for examination by soaking in a solution of strong potassa—although it is best to keep them in

the spirit whenever practicable; for this purpose a strong spirit should be diluted, else the animal is hardened and the shell damaged.

The animal may be best killed and removed from the shell by immersing in *boiling* water, and allowing it *gradually* to cool. This will loosen its muscular attachments, when it can be readily extracted, in most cases whole.

It is perhaps unnecessary to say that the value of shells in reference to indications of geographical distribution, will depend entirely upon the accuracy of their labels of station and locality. The greatest care should always be taken to mark down the locality at the time of collecting, if on a journey, and to verify as far as possible all statements in respect to this point relating to specimens obtained from others. Specimens received from other sources should always be packed and labelled separately from those obtained by the collector.

The west coast abounds in Limpets. These are found adhering to rocks at low water. Some are only seen at the ebb of spring tides; others live adhering to the fronds and stems of kelp, some being extremely small. The animals of all these should be preserved; and, as they drop out of the shells in spirit, each kind should be tied up separately. There are several slipper limpets (*Crepidulidæ*) and key-hole limpets (*Fissurellidæ*) to which attention is requested. They generally live attached to other shells. There is a very large species in which the shell is almost hidden (*Lucapina crenulata*), which should be always preserved in spirit. The *Chiton* tribe (woodlouse shells) deserve special attention. As they are apt to roll up into a ball, they should be tied flat to a strip of wood on being taken off the rock, and then immersed in spirit. A large species, in which the shelly plates are quite hidden, and the animal looks like a leathery lump, should be specially sought after. The animals of the great Ear Shells (*Haliotis*) should also be preserved in spirits. Of these and of the Limpets, and indeed of all shells, it is very desirable to collect individuals *of all ages*, especially of the youngest. If they be found in spawning season, the eggs should be preserved in spirit.

Special attention should be given to the Top Shells (*Trochidæ*) which, with all other univalve shells, should be carefully preserved with their *opercula*, or horny (sometimes shelly) lid on the mouth.

After a storm, the kelp and shore should be carefully searched for these and other shells.

The rocks and hardened mud banks should be searched for bivalves, which bore in them, and must be extracted by the hammer. They should be preserved in spirit. Some kinds make a cup or shelly tube outside the shell, which should be preserved. Most of the bivalves are found in the sand or sandy mud, and should be dug for where a little rising, or holes are seen. Salt marshes are particularly productive.

Most of the kinds can only be obtained alive by dredging,[1] especially on a bottom of sandy mud or gravel. But several rare deep-water species can be obtained by examining the contents of fishes' stomachs and intestines, where they are often found in quantities uninjured.

Some of the most interesting shells are extremely small. They may be picked off from the kelp or crevices of rocks at low water; and if there be sand, mud, or small gravel, especially from deep water, which contains small and broken shells, the larger shells may be packed up in it with advantage, after passing it through a fine sieve.

Land shells should be sought for in rainy weather, and in the early morning. The small kinds are often found on decayed bark or under stones. The naked slugs (as well as similar animals in the sea) should be preserved in spirit. The freshwater univalves will be found on stones, buried in mud, or among water plants; and the pond and river mussels at the bottom. None of the land or freshwater shells of the Pacific coast are as yet common in collections.

All information as to the station and habits of each species will be very acceptable. If they be kept in water (changing it constantly) and the animal drawn when in motion, very important knowledge may be gained.

The shells should be left with the dirt and all natural secretions adhering to them; nor should filing, acid, etc., on any account be employed with a view to improve their appearance.

[1] A figure of the dredge, and instructions for its use, will be found on page 39 of "Directions for making Collections of Natural History," published by this Institution. The pamphlet will be sent to any one desiring it, on application.

CIRCULAR

IN REFERENCE TO

THE DEGREES OF RELATIONSHIP AMONG DIFFERENT NATIONS.

In behalf of the Smithsonian Institution, I beg to commend to attention the accompanying letter and schedule of Mr. Lewis H. Morgan, of Rochester, N. Y. This gentleman has been engaged, for several years, in studying the ethnological peculiarities of the Indians of the North American Continent; and has discovered among them a system of relationship, which he wishes to compare with the systems of consanguinity existing among the natives of other countries.

From the annexed letter, it will be seen that General Cass has given this interesting enquiry the official sanction of the Department of State.

The answers to the circulars may be addressed to the Smithsonian Institution, care of the Department of State; and full credit will be given to all who furnish information bearing on this subject, when the results of these investigations are published.

I am, very respectfully,

Your obedient servant,

JOSEPH HENRY,

Secretary of the Smithsonian Institution.

Smithsonian Institution,

Washington, D. C., Jan. 20, 1860.

To the Diplomatic agents and Consuls

of the United States in foreign countries:

The accompanying circular and blank form have been prepared by L. H. Morgan, Esq., of Rochester, New York, for the purpose

of extending his ethnological investigations relative to the Indians of this continent to the other parts of the globe.

As the results of his investigations are to be published in the Smithsonian Contributions to Knowledge, I have been requested by the Secretary of the Smithsonian Institution, in this city, to commend the matter to your favor. I will consequently thank you to do whatever you conveniently can towards furnishing the information desired.

I am, gentlemen,
Your obedient servant,
LEWIS CASS.

DEPARTMENT OF STATE,
Washington, 5th January, 1860.

ROCHESTER, MONROE CO., N. Y.,
October 1st, 1859.

DEAR SIR: I take the liberty to send you, herewith enclosed, a printed schedule, with the request that you will take the trouble to fill it up according to its design, with the names of the various degrees of consanguinity and relationship which are in use among the people or tribe with or near whom you reside. In order that you may feel sufficient interest in the matter to induce you to comply with this request from a stranger, I would ask your attention to the object to which these inquiries are directed, to some of the results already reached, and to others still more interesting and important toward which they are manifestly tending.

Several years ago the peculiar system of relationship of the Iroquois, one of the principal American Indian families, attracted my attention. I found that, while it was very special and complex, it rested upon definite ideas, which stood to each other in such intelligent and fixed relations as to create a system. It is entirely unlike our own, both in its method of classification and in the ends it proposes to itself; as also unlike those of the remaining Indo-European nations, all of whom have substantially one and the same system. The fundamental idea of the Iroquois system, upon which it is built up with great logical rigor is, that it never suffers the bond of consanguinity to loose itself in the ever-

diverging collateral lines. The degrees of relationship are never allowed to pass beyond that of first cousin, after which the collateral lines revert into, or are merged in the lineal, in such a manner that the son of a man's cousin becomes his nephew, and the son of this nephew becomes his grandson. This principle works upwards as well as downwards, in such a manner, that the brother of a man's father becomes his father, and the brother of his grand-father becomes also his grand-father, in this, to us, novel system of consanguinity.

At first, I supposed that this peculiar system was confined to the Iroquois, and was a scheme of their own invention; but subsequent investigation disclosed the striking fact, that the system in all its complexity and precision is common to all the multitudinous Indian nations of North America, and most likely of both continents. At least, I have found, from schedules filled up and in my hands, with the exception of the Pawnee and Omaha, in which cases the schedules are but partially filled out, the system complete in the following Indian nations: the Iroquois and Wyandotte, who belong to the Hodenosaunian family; the Ojibwa, Otawa, Potowottomie, Peoria, Shawnee, Delaware, and Mohekuneuk, who belong to the Algonquin family; the Choctaw, which belongs to the Appalachian family; the Winnebagoe, Mississippi Dakota, Missouri Dakota, Iowa, Otoe, Kaw, and Omaha, who belong to the Dakotan family; and the Pawnee, which perhaps with the Arickaree, constitutes an independent family; making in all, sixteen different Indian nations, among all of whom the system is now in daily use.

Besides these, by means of the Indians above named who could speak for their kindred nations, and by information obtained from the French trappers and traders of the Upper Missouri, who have spent their lives in the mountains, and speak many Indian languages, I have been able to verify the present existence of the same system of relationship in the following additional nations: the Quappas, Osage, Sawk and Fox, Assinaboines, Mandan, and Sheyenne, who are Dakotans; the Kaskaskias, Piankashaws, Weaws, Miamis, Kikapoos, Menomines, and Blackfeet, who are Algonquins; the Arickarees, who are Pawnians; the Upsarokas or Crows, and the Gros-Ventres, whom I am not, at present, able

to place; and lastly the Shoshonees or Snake Indians, west of the Rocky Mountains, who are of the same family as the Comanches of Texas. In further addition to these, there are the Creeks, Chickaswas, and Seminoles, who may be presumed to have the system, as they are Appalachians. That it prevails among the Creeks I have satisfactory evidence from other sources.

The system is thus traced into thirty-six different Indian nations, comprising the principal historical races, who have, at times, occupied the whole area from the Rocky Mountains to the Atlantic, and from a point far up in the British Possessions, on the North, to the Gulf of Mexico and New Mexico, on the South.

The schedules, when compared, exhibit variations from uniformity, and occasional discrepancies, but the radical features of the system are constant in them all.

The most important of these are the following:

I.—All the brothers and sisters of a man's grand-father, and of his grand-mother, and all his ancestors above grand-father and grand-mother, together with all their brothers and sisters, are equally his grand-fathers and grand-mothers. Some of the nations discriminate among them as second and third grand-fathers, &c., but practically, they are all grand-fathers and grand-mothers. There are no great uncles, or great aunts, as with us.

II.—All the brothers of a father are equally fathers to his children, and he is a father to the children of all his brothers. In like manner, all the sisters of a mother are equally mothers to her children, and she is a mother to the children of all her sisters. These are not uncles and aunts, nephews and nieces, as with us.

III.—On the contrary, all the brothers of a mother are uncles to her children, and all the sisters of a father are aunts to his children, as with us; so that of the father's brothers and sisters, and of the mother's brothers and sisters, the mother's brothers and the father's sisters are the true and the only uncles and aunts recognized under this system.

IV.—There is one term for elder brother, another for younger brother; one term for elder sister, and another for younger sister; and no term either for brother or sister, except in the plural number. These separate terms are not applied to the oldest or the

youngest specifically, but to each and all, who are older or younger than the person speaking.

V.—All the children of several brothers are brothers and sisters to each other, and all the children of several sisters are brothers and sisters to each other, and they use, in each case, the respective terms for elder and younger brother, and for elder and younger sister, the same as in the case of own brothers and sisters. Whilst all the children of brothers on the one hand, and of sisters on the other, are cousins to each other, as with us. To this last rule their are exceptions. When you cross from one sex to the other, the degree of relationship is farther removed.

VI.—All the sons of a man's brothers as before stated, are his sons; so all the grand-sons of a man's brothers are his grand-sons. The sons of a man's sisters are his nephews, but the grand-sons of a man's sisters are his grand-sons. In the next collateral line the son of a man's female cousin is his nephew, and the son of this nephew is grand-son.

VII.—All the grandsons of brothers are brothers to each other, and the same of all the grandsons of sisters, while all the grandsons of brothers on the one hand, and of sisters on the other, are cousins; and the same relationship continues to the remotest generation in each case, so long as these persons stand in the same degree of nearness to the original brothers and sisters. But when one is farther removed than the other, by a single degree, the rule which changes the collateral line into the lineal at once applies: thus the son of one cousin becomes a nephew to the other cousin, and the son of this nephew a grandson. In like manner the son of one brother becomes a son to the other brother, and the son of this son, a grandson.

VIII.—Consequently, the descendants of brothers and sisters, or of an original pair, could not, in theory, ever pass beyond the degree of cousin, that being the most remote degree of relationship recognized, and the greatest divergence allowed from the lineal line. Hence the bond of consanguinity which can never, in fact, be broken by lapse of time, was not, as a fundamental idea of the Indian system, suffered to be broken in principle.

IX.—All the wives of these several brothers, without discrimination, and all the wives of these several male cousins, are inter-

changeably sisters-in-law to the brothers and cousins of their respective husbands; and all the husbands of these several sisters, without distinction, and of these several female cousins, are in like manner brothers-in-law to the sisters and cousins of their respective wives. All the wives of these several sons and nephews are daughters-in-law alike to the fathers and mothers, uncles and aunts of their respective husbands; and all the husbands of these several daughters and nieces, are sons-in-law alike to the fathers and mothers, uncles and aunts of their respective wives.

X.—In all the preceding cases the principle of correlative relationship is strictly applied: thus, the person whom I call son calls me father; the one I call grand-son calls me grand-father; and the same with uncle and nephew, aunt and niece, brother and brother, cousin and cousin, father-in-law and son-in-law, step-father and step-son, and thus onward through every recognized relationship.

This system, which, from its complexity and unlikeness to our own, is embarrassing to us, is yet perfectly natural and readily applied by the Indian, to whom any other than this is entirely unknown.

As an illustration of the method and nomenclature of the system, and of the manner of filling out the schedule, the following specimen may be taken in the Seneca dialect of the Iroquois language:

NOTE.—Care should be taken, in putting the questions on the schedule, against the error of receiving a simple translation of the question from the native. The special term by which he is called is the answer desired. The true form of each question is, "What do I call the person described by the question:" thus, "What do I call my father's brother's son?" &c. Answer, *My brother*.

Another rule should be observed. When one relationship is determined, the next in order will be based upon it usually: thus, my father's brother's son is "*my brother;*" therefore, my father's brother's son's son will be "*my son,*" if I am a man, and "*my nephew,*" if I am a woman; because he is the son of "*my brother,*" and because the son of my brother is *my son,* if I am a man, and *my nephew,* if I am a woman.

Description of Relationship.	Name of Native Word in English letters.	Translation of same into English.
My Father's Brother	*Hä'nih.*	My Father.
" " Brother's Son	*Hä'-je,* (if older)	" Elder Brother.
	Há-gă, (if younger)	" Younger Brother.
" " " Son's Wife	*Ah-ge-ah'-ne-ä*	" Sister-in-Law.
" " " Daughter	*Ah'-je,* (if older)	" Elder Sister.
	Ka'-gă, (if younger)	" Younger Sister.
" " " Daughter's Husband	*Ha-yă-o*	" Brother-in-Law.
" " " Son's Son, (said by a Male)	*Ha-ah'-wuk*	" Son.
" " " " (" Female)	*Ha-soh'-neh*	" Nephew.
" " " Son's Daughter, (said by a Male)	*Ka-ah-wuk*	" Daughter.
" " " " (" Female)	*Ka-soh'-neh*	" Niece.
" " " Daughter's Son, (said by a Male)	*Ha-yă'-wan-dă*	" Nephew.
" " " " (" Female)	*Ha-ah'-wuk*	" Son.
" " " Daughter's daughter, (said by a Male)	*Ka-yă'-wan-dă*	" Niece.
" " " " " (" Female)	*Ka-ah'-wuk*	" Daughter.
" " " Great-Grand Son	*Ha-yä'-da*	" Grand Son.
" " " " Daughter	*Ka-yä-da*	" " Daughter.
My Father's Sister	*Ah-gá-hue*	My Aunt.
" " Sister's Son	*Ah-găre'-seh*	" Cousin.
" " " Son's Wife	*Ah-ge-ah'-ne-ä*	" Sister-in-Law.
" " " Daughter	*Ah-găre'-seh*	" Cousin.
" " " Daughter's Husband	*Ha-yă'-o*	" Brother-in-Law.
" " " Son's Son, (said by a Male)	*Ha-ah'-wuk*	" Son.
" " " " (" Female)	*Ha-soh'-neh*	" Nephew.
" " " Son's Daughter, (said by a Male)	*Ka-ah'-wuk*	" Daughter.
" " " " (" Female)	*Ka-soh'-neh*	" Niece.
" " " Daughter's Son, (said by a Male)	*Ha-yă-wan-dă*	" Nephew.
" " " " (" Female)	*Ha-ah'-wuk*	" Son.
" " " Daughter's Daughter, (said by a Male)	*Ka-yă'-wan-dă*	" Niece.
" " " " " (" Female)	*Ka-ah'-wuk*	" Daughter.
" " " Great-Grand Son	*Ha-yä'-da*	" Grand Son.
" " " " Daughter	*Ka-yä'-da*	" " Daughter.

It is not necessary in this place to discuss the variations from uniformity which a careful comparison of the several schedules has revealed; but the one most important may be adverted to, in this connection, as it may appear in the systems of other nations, and finally receive an explanation. It is this: the son of a man's father's sister is his cousin among the Iroquois, the Dakotas, and the Otawas, &c., who represent three stock languages; while among the Iowas, Otoes, Kaws and Shawnees, who represent two of the same stock languages, he is a nephew; and among the Choctaws, who represent a fourth stock language, he is a father; so that in one case the same persons are cousins to each other, in another, uncle and nephew, and in another, son and father.

The universal prevalence, among the North American Indians, of a system of consanguinity and relationship so exceedingly complex, was sufficiently remarkable to suggest some questions as to what might be its ethnological value. Its permanency was sufficiently illustrated by its universal prevalence through a period of time, in which every word of some of the languages had undergone such changes as to be wholly unintelligible to the people of other languages, in which the system itself had undergone no material modification. Consequently it seemed to indicate the unity of origin of all these Indian nations, which though probable before, was not so well established as to leave undesirable the further evidence to be derived from this source. The ancientness upon this continent of the Red race, assuming its original unity, was rendered manifest by the number of ages which would be required for an original language to fall into several languages so entirely changed in their vocabularies as to lose all internal evidence, from this source, of their original connection; and for these, in turn, to fall into the multitudinous dialects in which they are now spoken. This permanency and this universality of the system, therefore, could scarcely be understood in any other way, than by the assumption that this system itself was as old as the Indian race on this continent. If, then, the Red race was of Asiatic origin, it became very probable that they brought it with them from Asia, and left it behind them in the stock from which they separated.

These deductions naturally led to the extension of the field o inquiry to the old world, and particularly to those Scythic peoples, with whom it was supposed, on other ethnological grounds, the Red race would affiliate, if ever successfully traced to an Asiatic original. Hence, these schedules have been distributed in some portions of Asia, and in some of the islands of the Pacific, in order to discover whether this system is confined to the American Indians, or is indeed common with them, and the Mongolian, Tungusian, Turkish, and Finnish families, whose languages constitute what is now known as the Scythian group of tongues.

But two schedules have, as yet, been obtained, and these but partially filled, although fortunately the prominent and indicative features of the system of each are presented. They contain the principal degrees of consanguinity and relationship of the Tamil and Telugu peoples of southern India, numbering about twenty-four millions, who, with the Canarese, the Malayalam, the Tulu, and a few subordinate Dravidian races, have been recognized as an Ante-Brahminical people, having their nearest affinities with the Scythian families above mentioned.

A comparison of the Tamil and Telugu schedules shows that the systems of these races are identical; leading to the same inference of their genetic connection, which has been drawn from the similarity of the Iroquois and the Dakotas as to them. A further comparison of the Tamil and Telugu system, with that of the American Indians, discloses the extraordinary fact, that so far as we have the present means of comparison, they are nearly identical. To what extent the Asiatic and the American Indians have the system in common, will appear by the following statement of the principal features of the Tamil and Telugu system, which are the following:

I —All the brothers of a father are usually called *fathers*, (Tăkăppăn,*) but in strictness, those who are older than the father are called *great fathers*, (Pĕrīyă Tăkăppăn,) and those who are younger, *little fathers*, (Sĕriyă Tăkăppăn;) so that in any event all the father's brothers are *fathers*, and not *uncles*.

* These words are in the Tamil language, and all of them are used in the singular number.

II.—All the sisters of a mother are usually called *mothers* (Täy;) but in strictness, when older or younger, great and little mothers, as in the former case. So that in like manner, all the sisters of a mother are *mothers,* and not *aunts.*

III.—On the contrary, all the brothers of a mother are uncles (Mămăn) to her children, and all the sisters of a father are aunts (Attai) to his children; so that the mother's brothers and father's sisters are the true and the only uncles and aunts recognized under the Dravidian system.

IV.—There is one term for elder brother, (Annăn,) another for younger brother, (Tămpĭ;) one term for elder sister, (Akkăl,) and another for younger sister, (Tăngkăchchŭ,) and no term either for brother or sister. These separate terms are not applied to the oldest and youngest specifically; but to each and all who are older or younger than the person speaking.

V.—All the children of several brothers are brothers and sisters to each other, and all the children of several sisters are brothers and sisters to each other; and they use in each case the respective terms for elder and younger brother and for elder and younger sister, the same as in the case of own brothers and sisters, and as given in the foregoing illustration from the Iroquois system.

VI.—All the children of brothers on the one hand, and of the brother's sisters on the other, are cousins (Măittŭnăn) to each other, as in the American system.

VII.—All the sons of a man's sisters are his nephews, (Mărŭmăkăn,) and all the daughters of a man's sisters are his nieces, (Mărŭmăkăl.) So also, all the sons and daughters of a woman's brothers are her nephews and nieces. But whether all the sons and daughters of a man's brothers are called his sons and daughters; and whether all the sons and daughters of a woman's sisters are her sons and daughters, these schedules do not show. It is to be inferred that they are, from the use by these persons of the correlative terms.

If, in addition to these particulars, the grand-fathers and grand-mother's brothers and sisters are all alike grand-fathers and grand-mothers; if the grand-sons of a man's brothers and sisters are his grand-sons; and if the son of a man's female cousin is his nephew, and the son of this nephew is a grand-son, then all

the radical features of the American Indian are present in the Telugu and Tamilian system of relationship.

Can these coincidences be accidental? While this is not the proper place to discuss, either the extent or the conclusiveness of the evidence here afforded of the Asiatic origin of the American Indian race, yet it is not too much to say, that the remarkable similarity of their systems of consanguinity in so many special features, furnishes no slight indication that further research will draw forth such additional evidence as may lead to a final solution of this problem.

Should this fact become thus established, we cannot fail to perceive the important bearing which a comparison of the several systems of consanguinity and relationship of the human race will have upon the remaining question of their common origin. Language, which has been the great instrument in this inquiry, changes its vocabulary not only, but also modifies its grammatical structure in the progress of ages, thus losing the certainty of its indications, with each new foot-hold gained in the past. But the ideas deposited in a system of consanguinity, and standing to each other in such fixed relations as to create a system, are mostly independent of all changes in language, and of the lapse of time, and depend for their vitality in the human mind, upon their prime necessity and approved usefulness. The system of the Indo-European nations has stood without essential change for upwards of thirty centuries in the lexicons of the Latin, Greek, and Sanscrit languages. That of the Tamil and Telugu races has an antiquity equally great, having survived the Brahminical conquest, the substitution of a new religion, and the imposition upon them of the law of Caste; while that of the American Indians bears internal evidence of the same great age and permanency.

Sufficient has been said to show, at least, that the further prosecution of this inquiry, in which your coöperation is respectfully solicited, promises results of some importance. Can you be persuaded to furnish to the undersigned the system of relationship, written out upon the enclosed schedule, of the native race among or near whom you reside? It is certainly a request unsupported by any of the ordinary motives of interest, but it is not therefore proffered without a hopeful expectation of a favorable response.

This letter and schedule will be forwarded by the Smithsonian Institution of Washington to the principal diplomatic and consular officers of the United States in foreign countries, to the United States army officers at the several military posts, and also to the principal missionaries of the English and American Boards, it being the intention of the Institution to give to them a wide distribution over Asia, Africa, the Islands of the Pacific, Mexico, and South America, as well as within our own territories. Such schedules as are returned will be printed over the names of the persons by whom they are prepared, and proper acknowledgments rendered. While these schedules are making their distant visitations, the work will be continued among the American Indians, with a view to settle the question whether the system is universal among them.

It remains to make some explanations of this schedule, which, although it has a formidable appearance, is not intrinsically difficult. The word "My" is the starting point; the point occupied by "myself," the questioner; and the relationship sought is that which the person at the opposite end bears to me: thus, "my father's brother's son's wife" is "my sister-in-law." A difficulty somewhat embarrassing at first, arises from the fact that the relationship is very different in some cases where the questioner is a male, from what it is where the questioner is a female: thus, "My father's brother's son's son" is my *son*, if I am a man, but he is my *nephew*, if I am a woman. To meet this peculiarity the question is put twice, once "said by a male," and once "said by a female." It will assist materially in working the schedule to keep in mind the last relationship written down, as we naturally follow the chain of kindred step by step, the last degree indicating the one to succeed.

All languages describe relationships by using the possessive form of the noun, as "father's sister's son," but most of them have a special word for the same relationship, as "cousin." It is necessary, in the present case, to have the special word or term, and also that it should be spelled with English letters, even though the language has alphabetic characters, and that the word be also translated into equivalent English. Unless both of these condi-

tions are met, it will be difficult to make any use of the schedule.* The principal vowel marks are indicated; but if others are used either for vowels or consonants, the key to the same should be given. As one of the pronouns *my*, *our*, or *his*, is incorporated, in most languages, with the term of relationship, it is desirable to have these pronouns given in every case, and accordingly a place has been made for them on the schedule. The accented syllables should also be marked.

Several questions are appended concerning tribal organization, the answers to which will have an important bearing upon the full interpretation of the system of relationship, with which they are intimately connected. A brief explanation of two or three prominent characteristics of a Tribe will conclude this letter.

Nearly all, if not all, of the Indian Nations upon this continent were anciently subdivided into *Tribes* or *Families*. These Tribes, with a few exceptions, were named after animals. Many of them are now thus subdivided. It is so with the Iroquois, Delawares, Iowas, Creeks, Mohaves, Wyandottes, Winnebagoes, Otoes, Kaws, Shawnees, Choctaws, Otawas, Ojibewas, Potowottomies, &c.

The following tribes are known to exist, or to have existed, in the several Indian Nations—the number ranging from three to eighteen in each: The Wolf, Bear, Beaver, Turtle, Deer, Snipe, Heron, Hawk, Crane, Duck, Loon, Turkey, Musk-Rat, Sable, Pike, Cat-Fish, Sturgeon, Carp, Buffalo, Elk, Rein-Deer, Eagle, Hare, Rabbit and Snake; also, the Reed-Grass, Sand, Water, Rock and Tobacco-Plant.

Among the Iroquois, and the rule is the same to the present day in most of the nations enumerated, no man is allowed to marry a woman of his own tribe, all the members of which are consanguinei. This was unquestionably the ancient law. It follows that husband and wife were always of different tribes. The children are of the tribe of the *mother*, in a majority of the nations; but the rule, if anciently universal, is not so at the present day. Where descent in the female line prevailed, it was followed by several important results, of which the most remarkable was

* The error in some cases has occurred of translating the questions on the schedule, instead of giving the special term.

the perpetual disinheritance of the male line. Since all titles as well as property descended in the female line, and were hereditary, in strictness, in the tribe itself, a son could never succeed to his father's title of Sachem, nor inherit even his medal or his tomahawk. If the Sachem, for example, was of the Wolf tribe, the title must remain in that tribe, and his son, who was necessarily of the tribe of his mother, would be out of the line of succession; but the brothers of the deceased Sachem would be of the Wolf tribe, being of the same mother, and so would the sons of his sisters: hence we find that the succession fell either upon a brother of the deceased ruler or upon a nephew. Between a brother of the deceased, and the son of a sister, there was no law establishing a preference; neither as between several brothers on one side, or several sisters on the other, was there any law of primogeniture. They were all equally eligible, and the law of election came in to decide between them.

The tribal organization, and the system of relationship lie at the foundation of Indian society. They represent and express ideas as old as the race itself, which are freighted with testimony of the highest ethnological value. Upon precisely such ideas as these, which have been deposited in the family life of a race, we may yet be able to ascend through the generations far back upon the covered footsteps of the human race, and re-associate nations and races, whose original connection has passed from human knowledge. Along the pathway of these generations, which is marked with epochs of migration from age to age, every divergence of a family from the parent stock would carry with it the same ideas, spreading them upon the track of each new migration, perchance into the most distant parts of the earth. It is not impossible that we may, at no distant day, be able to re-ascend the several lines of the out-flow of the generations, and reach and identify that parent stock, from which, we believe, we are all alike descended.

Yours, respectfully,

LEWIS H. MORGAN.

The questions before referred to are the following:

1. Into how many Tribes is the Nation divided? Give the name of each Tribe in the native language, and a translation into English.
2. Was a man forbidden to marry a woman of his own Tribe?
3. Were the children of the Tribe of the Mother, or of the Tribe of the Father?
4. Was the office of Sachem or principal chief hereditary in the Tribe?
5. Was it elective as among the near relatives of the deceased Sachem of the same Tribe?
6. Did the Son succeed the Father; or a Brother, or a Sister's Son?
7. Were the duties of a Sachem confined exclusively to the affairs of peace?
8. Was the office of War Chief elective, in reward of merit, and non-hereditary?
9. Were the descendants of two Sisters of the same sex, standing in equal degrees from their common ancestors, Brothers and Sisters to each other, in theory, through all generations? Were the descendants of two brothers the same? Were the descendants of a Brother, and of a Sister, in the same manner, Cousins?
10. Were the names of individuals changed at different periods, by national custom? That is: had they one class of names for childhood, another for manhood, and still another for advanced age, which were successively changed?
11. Upon the death of the Father, to whom did his property descend?
12. Upon the death of the Mother, to whom did her property descend?
13. If the people are divided into Castes, are these Castes subdivided?
14. If so, are these subdivisions analagous, in any particular, to the Tribes of the American Indians?
15. Can a man of one of these subdivisions marry a woman of the same subdivision?
16. Are the members of each subdivision regarded as consanguinei?
17. Do relatives salute each other by the term of relationship?

Degrees of Relationship in the Language of the Nation.

MADE BY (Name.) (Residence) (Date.) 1860.

VOWEL SOUNDS.—ä, as in art; ă, as in at; ĕ, as in met; ĭ, as in it; ŏ, as in got; ŭ, as oo in food.

☞ *Please mark the accented syllables.*

INSERT NATIVE PRONOUNS—MY,..........OUR,..........HIS..........

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
1. My Father..........	....	....
2. " Mother..........	....	....
3. " Son..........	....	....
4. " Daughter..........	....	....
5. " Grand-Son..........	....	....
6. " Grand-Daughter..........	....	....
7. " Great-Grand-Son..........	....	....
8. " " Daughter..........	....	....

9. My Great-Great-Grand-Son		
10. " " Daughter		
11. " Elder Brother, (said by a Male)		
12. " " " (" Female)		
13. " Elder Sister, (" Male)		
14. " " " (" Female)		
15. " Younger Brother, (said by a Male)		
16. " " " (" Female)		
17. " " Sister, (" Male)		
18. " " " (" Female)		
19. " Brothers		
20. " Sisters		
21. " Father's Brother		
22. " " Elder Brother		
23. " " Younger Brother		
24. " " Brother's Wife		
25. " " Sister		

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
26. My Father's Sister's Husband		
27. " Mother's Brother		
28. " " Brother's Wife		
29. " " Sister		
30. " " Elder Sister		
31. " " Younger Sister		
32. " " Sister's Husband		
33. My (a Man's) Brother's Son		
34. " " " Son's Wife		
35. " " " Daughter		
36. " " " Daughter's Husband		
37. " " " Grand-Son		
38. " " " " Daughter		

39. " " " Great-Grand-Son		
40. " " " " " Da'ter.		
41. My (a Man's) Sister's Son		
42. " " " Son's Wife		
43. " " " Daughter		
44. " " " Daughter's Husband		
45. " " " Grand-Son		
46. " " " " Daughter		
47. " " " Great-Grand-Son		
48. " " " " " Da'ter.		
49. My (a Woman's) Sister's Son		
50. " " " Son's Wife		
51. " " " Daughter		
52. " " " Daughter's Husb'd		
53. " " " Grand-Son		
54. " " " " Daughter		
55. " " " Great-Grand-Son		

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
56. My (a Woman's) Sister's Great-Grand-D'ter		
57. " " Brother's Son		
58. " " " Son's Wife		
59. " " " Daughter		
60. " " " Da'ter's Husb'd		
61. " " " Grand-Son		
62. " " " " Daughter		
63. " " " Great-Grand-Son		
64. " " " " " D'r		
65. My Father's Brother's Son, (said by a Male)		
66. " " " " (" Female)		
67. " " " Son's Wife, (said by a Male)		

68.	"	"	"	Son's Wife, (said by a Female)...........		
69.	"	"	"	Daughter, (said by a Male)................		
70.	"	"	"	Daughter, (said by a Female)		
71.	"	"	"	Daughter's Husband, (said by a Male)...		
72.	"	"	"	Daughter's Husband, (said by a Female)		
73.	"	"	"	Son's Son, (said by a Male)................		
74.	"	"	"	Son's Son, (said by a Female)		
75.	"	"	"	Son's Daughter, (said by a Male)...........		
76.	"	"	"	Son's Daughter, (said by a Female)		
77.	"	"	"	Daughter's Son, (said by a Male)..........		
78.	"	"	"	Daughter's Son, (said by a Female)........		
79.	"	"	"	Daughter's Daughter, (said by a Male)...		
80.	"	"	"	Daughter's Daughter, (said by a Female)		
81.	"	"	"	Great-Grand-Son, (said by a Male)...		
82.	"	"	"	Great-Grand-Son, (said by a Female)		
83.	"	"	"	Great-Grand-Da'ter, (said by a Male)...		

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
84. My Father's Brother's Great-Grand-Da'ter, (said by a Female)		
85. " " " Gr't-Gr't-Grand-Son.		
86. " " " Gr't-Gr't-Grand-D'r..		
87. My Father's Sister's Son, (said by a Male)..		
88. " " " " (said by a Female)		
89. " " " Son's Wife, (said by a Male.		
90. " " " Son's Wife, (said by a Female)		
91. " " " Da'ter, (said by a Male)		
92. " " " Da'ter, (s'd by a Female)		
93. " " " Daughter's Husband, (said by a Male)		
94. " " " Daughter's Husband, (said by a Female)...		

95.	" " " Son's Son, (said by a Male)		
96.	" " " Son's Son, (said by a Female)		
97.	" " " Son's Daughter, (said by a Male)		
98.	" " " Son's Daughter, (said by a Female		
99.	" " " Daughter's Son, (said by a Male)		
100.	" " " Daughter's Son, (said by a Female)		
101.	" " " Daughter's Daughter, (said by a Male)		
102.	" " " Daughter's Daughter, (said by a Female)		
103.	" " " Great-Grand-Son		
104.	" " " " " Daughter		
105.	" " " Great-Great-Gr'd-Son.		
106.	" " " " " Gr'd-D'r.		
107.	My Mother's-Sister's Son, (said by a Male)		
108.	" " " " (s'd by a Fem'le)		
109.	" " " Son's Wife, (said by a Male)		
110.	" " " Son's Wife, (said by a Female)		

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
111. My Mother's Sister's Daughter, (said by a Male)........	....	....
112. " " " Daughter, (said by a Female)........	....	....
113. " " " Daughter's Husband, (said by a Male)...	....	....
114. " " " Daughter's Husband, (said by a Female)	....	....
115. " " " Son's Son, (said by a Male)........	....	....
116. " " " Son's Son, (said by a Female)........	....	....
117. " " " Son's Daughter, (said by a Male)........	....	....
118. " " " Son's Daughter, (said by a Female)........	....	....
119. " " " Daughter's Son, (said by a Male)........	....	....
120. " " " Daughter's Son, (said by a Female)........	....	....
121. " " " Daughter's Daughter, (said by a Male)...	....	....
122. " " " Daughter's Daughter, (said by a Female)	....	....

123. " " " Great-Grand-Son, (said by a Male)...	....	....
124. " " " Great-Grand-Son, (said by a Female)	....	....
125. " " " Great-Grand-Da'ter..	....	....
126. " " " Gr't-Gr't-Grand-Son.	....	....
127. " " " Gr't-Gr't-Grand-D'r..	....	....
128. My Mother's Brother's Son, (said by a Male)	....	....
129. " " " " (" Female)	....	....
130. " " " Son's Wife, (said by a Male)...............	....	....
131. " " " Son's Wife, (said by a Female)...........	....	....
132. " " " Daughter, (said by a Male)................	....	....
133. " " " Daughter, (said by a Female)..............	....	....
134. " " " Daughter's Husband, (said by a Male)...	....	....
135. " " " Daughter's Husband, (said by a Female)	....	....
136. " " " Son's Son, (said by a Male)................	....	....
137. " " " Son's Son, (said by a Female)..............	....	....
138. " " " Son's Daughter, (said by a Male)..........	....	....

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
139. My Mother's Brother's Son's Daughter, (said by a Female)		
140. " " " Daughter's Son, (said by a Male)		
141. " " " Daughter's Son, (said by a Female)		
142. " " " Daughter's Daughter, (said by a Male)		
143. " " " Daughter's Daughter, (said by a Female)		
144. " " " Great-Grand-Son		
145. " " " Great-Grand-Da'ter		
146. " " " Gr't-Gr't-Grand-Son		
147. " " " Gr't-Gr't-Grand-D'r		
148. My Grand-Father, (*Father's Side*)		
149. " " Father's Brother, "		
150. " " " Sister, "		

151. " Grand-Mother, "		
152. " Grand-Mother's Brother, "		
153. " " Sister, "		
154. " Great-Grand-Father, "		
155. " Gr't-Grand-Father's Brother "		
156. " " Sister, "		
157. " Great-Grand-Mother, "		
158. " Gr't-Grand-Mother's Brother "		
159. " " Sister, "		
160. " Great-Great-Grand-Father, "		
161. " " Mother, "		
ARE THESE RELATIONSHIPS THE SAME ON MOTHER'S SIDE?		
162. My Father's Father's Sister's Son, (said by a Male)		
163. " " " " Daughter, (said by a Male)		
164. " " " " Son's Son, (said by a Male)		
165. " " " " Son's Da'ter, (said by a Male)		
166. " " " " Da'ter's Son, (said by a Male)		

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
167. My Father's Father's Sister's Da'ter's Da'ter (said by a Male)..	....	....
168. " " " " Gr't-Gr'd-Son, (said by a Male)..	....	....
169. " " " " Gr't-Gr'd-D'r, (said by a Male)..	....	....
170. " Mother's Mother's Sister's Son, (said by a Male)........	....	....
171. " " " " Daughter, (said by a Male)..	....	....
172. " " " " Son's Son, (said by a Male)..	....	....
173. " " " " Son's Da'ter, (said by a Male)..	....	....
174. " " " " Da'ter's Son, (said by a Male)..	....	....
175. " " " " Da'ter's Da'ter (said by a Male)..	....	....
176. " " " " Gr't-Gr'd-Son, (said by a Male)..	....	....
177. " " " " Gr't-Gr'd-D'r, (said by a Male)..	....	....
178. " Mother's Mother's Mother's Sister's D'r, (said by a Male)..	....	....

179. " Mother's Mother's Mother's Sister's Grand Da'ter, (said by a Male)........	....	....
180. " Mother's Mother's Mother's Sister's Gr't-Gr'd-Da'ter, (said by a Male)....	....	....
181. " Mother's Mother's Mother's Sister's Gr't-Gr't-Gr'd-D'r, (said by a Male)..	....	....
182. " Husband..	....	....
183. " Wife	....	....
184. " Husband's Father..	....	....
185. " " Mother..	....	....
186. " " Grand-Father..	....	....
187. " Wife's Father	....	....
188 " " Mother..	....	....
189. " " Grand-Mother	....	....
190. " Son-in-Law (said by a Male)	....	....
191. " " (" Female)..	....	....
192. " Daughter-in-Law, (said by a Male)..	....	....
193. " " (" Female)...	....	....
194. " Step-Father..	....	....

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
195. My Step-Mother		
196. " Step-Son		
197. " Step-Daughter		
198. " Adopted Son		
199. " " Daughter		
200. " Half-Brother		
201. " Half-Sister		
202. " Two Fathers-in-law to each other		
203. " Two Mothers-in-Law to each other		
204. " Brother-in-Law, (Husband's Brother)		
205. " " (Sister's Husband,) (said by a Male)		
206. " " (Sister's Husband,) (said by a Female)		

207. " " (Wife's Sister's Husb'd)		
208. " " (Wife's Brother)		
209. " " (Husb'd's Sister's Husb)		
210. " Sister-in-Law, (Wife's Sister)		
211. " " (Husband's Sister)		
212. " " (Brother's Wife,) (said by a Male)		
213. " " (Brother's Wife,) (said by a Female)		
214. " " (Husb'd's Broth's Wife)		
215. " " (Wife's Brother's Wife)		
216. Twins		
217. Widow		
218. Widower		
(*Relationship of the Descendants of Brothers and Sisters to each other.*)		
1. The Daughter, of the Daughter, of one Sister, to the Daughter, of the Daughter, of the other Sister		
2. The Son, of the Son, of one Sister, to the Son, of the Son, of the other Sister		

DEGREES OF RELATIONSHIP—Continued.

Description of Relationship.	Name, or Native Word, in English Letters.	Translation of the same into English.
3. The Son, of the Son, of one Sister, to the Daughter, of the Daughter, of the other Sister		
4. The Daughter, of the Son, of one Sister, to the Son, of the Daughter, of the other Sister		
5. The Daughter, of the Daughter, of the Daughter, of one Sister, to the Daughter, of the Daughter, of the Daughter, of the other Sister		
1. The Son, of the Son, of one Brother, to the Son, of the Son, of the other Brother		
2. The Daughter, of the Daughter, of one Brother, to the Daughter, of the Daughter, of the other Brother		
3. The Son, of the Son, of one Brother, to the Daughter, of the Daughter, of the other Brother		
4. The Son, of the Son, of the Son, of one Brother, to the Son, of the Son, of the Son, of the other Brother		
1. The Son, of the Son, of a Brother, to the Son, of the Son, of the Brother's Sister		
2. The Daughter, of the Daughter, of a Brother, to the Daughter, of the Daughter, of the Brother's Sister		

3. The Son, of the Son, of a Brother, to the Daughter, of the Daughter, of the Brother's Sister		
4. The Son, of the Son, of the Son, of a Brother, to the Son, of the Son, of the Son, of the Brother's Sister		
1. The Daughter, of the Daughter, of one Sister, to the Daughter, of the Daughter, of the Daughter, of the other Sister		
2. The Son, of the Son, of one Brother, to the Son, of the Son, of the Son, of the other Brother		
3. The Daughter, of the Daughter, of a Brother, to the Son, of the Son, of the Son, of the Brother's Sister		